



NRL/MR/6110--06-9002

Methane Hydrate Exploration, Atwater Valley, Texas-Louisiana Shelf: Geophysical and Geochemical Profiles

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December 27, 2006

Cruise Report

RV Gyre, May 10-20, 2004

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vii. ABSTRACT

From May 14 - 20, 2004 piston core and heat flow measurements were collected across two mound structures, mound D and mound F, in an area designated as Atwater Valley, a shallow trough on the continental slope south of the Mississippi Delta. Atwater Valley lies at 1,200 to 1,500 meters water depth. Several small mound structures occur in the valley, rising less than 50 meters above the surrounding seafloor. Coring plans were designed to support Chevron-Texaco JIP drilling completed during 2005. The USGS collected several multichannel seismic lines in this area in 2003. During 4 days on site we acquired 15 piston cores and 23 thermal profiles on a transect from mound F to mound D. A previous USGS seismic line (AV65) and a 3.5 kHz echosounder profile collected during the cruise were used to guide operations. All cores had good penetration, (shortest was 255 cm, longest 842 cm), and no carbonate pavement or hydrate mounds were encountered. The cores were immediately sectioned and sampled for chemical analysis. No detailed sedimentological examinations were made. All attempts at thermal probing resulted in sufficient penetration, except for one instance where the instrument laid horizontal on the seafloor.

The sulfate-methane interface (SMI) estimated from pore water sulfate profiles indicated a range in the vertical flux of methane. Sulfate and methane pore water profiles from piston cores on mound F indicated the greatest vertical methane flux in this study region. Sulfate was depleted in surface core samples and methane concentrations were elevated suggesting a flow of methane into the water column. Overall the SMI across the transect ranged from 45 to 410 cm. Stable carbon isotope ratios and speciation of gases sampled from the piston cores indicated a microbial source of methane. Chloride data from piston cores did not indicate hydrates were sampled and dissociated during transport from the sediment and deck processing. However, high chloride concentrations were measured on mound F. It is expected that the chloride originated from deep salt diapirs. DIC concentrations and stable carbon isotope analysis confirmed anaerobic methane oxidation in the pore water profiles. Mound F sites showed shallower DIC concentration peaks and more ^{13}C depletion in the DIC. These data are consistent with increased vertical methane flux in this region. Data were also sorted according to the Chevron-Texaco JIP planning for deep well drilling. Chevron-Texaco sites JIP-1 and JIP-5 are located on mound F. Methane, sulfate, chloride, DIC and DIC $\delta^{13}\text{C}$ all indicate this region is the most active in vertical methane flow. Sites JIP-2 (between mounds D and F), JIP-3 (between mounds D and F) and JIP-4 (mound D) were found to have deeper SMI profiles.

Heatflow probing was conducted at each of the piston coring sites; additional sites, relative to the piston coring, were included for more resolution. The data show clear anomalies in sediment temperature and heat flow associated with the mounds. Measurements collected on the top of mound F show elevated sediment temperatures, and heat flow values of around 160 mW/m^2 . Sediment temperatures decrease away from the summit of the mound, and heat flow values drop to a background level of 40 to 50 mW/m^2 . Sediment temperatures at the summit of Mound D are similar to what was observed at Mound F, and heat flow values are slightly lower at around 132 mW/m^2 , partly as a result of the slightly higher bottom water temperature and thus reduced thermal gradient. Away from the summit of Mound D the thermal gradient decreases and heat flow values drop to around 50 mW/m^2 .

I. INTRODUCTION

A tremendous quantity of methane hydrate, clathrate, is embedded in the sea floor along most continental margins of the world, and in permafrost at high latitudes. Distribution of organic carbon in the earth's crust in methane hydrates in oceans and the permafrost regions is estimated to be more than twice that contained in recoverable and non-recoverable fossil fuel (including coal, oil and natural gas). If extracted, the quantity of methane trapped in ocean sediments represents a large potential energy resource. The U.S. Geological Survey estimates the resource potential in the United States to be about 200,000 trillion cubic feet. The current annual consumption of natural gas is about 22 trillion cubic feet. Based on these estimates, at about 1% recovery the deposit has the potential to fill the natural gas needs of the nation, at the present rate of consumption, for the next 100 years. Additionally, for direct fuel combustion methane not only provides high energy density per weight, but relatively low CO₂ emissions. While a great deal of research is underway to understand the nature of hydrate deposits in the oceans and the permafrost regions, the safe and economic extraction of methane from hydrates is not close at hand. Besides the potential as an energy source, methane hydrates are also important to global climate, coastal slope stability, ocean carbon cycling and global economy. The U. S. Geological Survey and the Naval Research Laboratory are engaged in field and laboratory work designed to evaluate the hydrate resource in the Gulf of Mexico.

This project was designed to study methane hydrate distribution in the Atwater Valley, on the Texas-Louisiana Shelf, in the Gulf of Mexico. The hydrate survey was conducted with integration of seismic profiles, heatflow probing, and geochemical analysis of piston cores. The principal goals of this project were to: 1) test integration of geophysical and geochemical parameters to evaluate methane hydrate distribution; 2) develop of a more thorough data base for understanding methane hydrate distribution, 3) provide a field evaluation to support planning of the Chevron-Texaco JIP deep drilling in this region, and 4) compare the Chevron-Texaco deep drilling with the geochemical/geophysical prediction of deep sediment hydrate distribution. Data obtained from this survey contributes to the NRL database being developed from research off the US, Canadian, Chilean and Japanese coasts.

Piston cores were analyzed for hydrate presence, pore water chemistry and the source of the methane in the hydrates. Parameters include sulfate, chloride and stable carbon isotope analysis of DIC in pore waters and methane from gas pockets in the sediment core liner. Seismic data were used to constrain interpretation of the geochemical data. Sulfate and methane profiles were used to assess the vertical flux of methane. Stable carbon isotope analyses were used to determine whether the source of methane is thermogenic or microbial in origin.

In past research along the Texas-Louisiana Shelf hydrate gases have been found to be of thermogenic origin. NRL analysis of gas composition and stable carbon isotope ratios of 19 cores from Keathley Canyon during the August 2003 cruise found that the methane was through microbial production. There was no evidence for any significant (>0.1%) thermogenic gas input. The geochemical survey of Atwater Valley will provide an interesting comparison to similar data obtained from Keathley Canyon and other locations.

II. GENERAL INFORMATION

1. Environmental Effects

The heat flow probe and piston coring devices are each approximately 10 cm in diameter and penetrate the sea floor for up to 8 m and can cause some disturbance to the sea floor during penetration and removal. The piston coring also recovers samples of the shallow seafloor that are used for chemical analysis. There were 23 heat flow stations and about 15 piston cores through the two focus sites, mounds D and F. This equipment is standard equipment used by the academic and research community extensively in most of the oceans of the world. The measurements are routine, and disturbance of the sea floor is expected to be minimal. MMS verified that there were no man-made structures in either area that might be damaged by the use of these devices. The seismic data was acquired prior to coring and thermometry and preliminary imaging to provide an outline for locations of hard ground, which were avoided not only to protect chemosynthetic communities but also to prevent damage to the equipment.

2. Participants

Table 1: Participating research scientists

| Scientist | Affiliation | Responsibility | Phone Number | Email |
|--------------------|-----------------------|-----------------|--------------|--------------------------------------------------------------------------------|
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| John Pohlman | VIMS | Onboard Lab | 202-404-3365 | johnp@ccs.nrl.navy.mil |
| Dr. Warren Wood | NRL, Code 7432 | Geophysic input | 228-688-5311 | warren.wood@nrlssc.navy.mil |
| Dr. Richard Hagen | NRL, Code 7420 | Heatflow | 202-404-1125 | rhagen@qur.nrl.navy.mil |
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| Daniel Bean | TAMU | Piston Coring | 979-845-7536 | dabeau@ocean.tamu.edu |
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| Kiara Smith | VIMS | Lab Analysis | 757-874-7294 | kiara@vims.edu |
| Mary Cathey | USC | Lab Analysis | 864-958-1824 | MCATHEY@sc.rr.com |

3. Site Description

Heatflow measurements and piston cores were collected across two mound structures in an area designated as Atwater Valley, a shallow trough on the continental slope south of the Mississippi Delta, on the Texas-Louisiana Shelf, in the Gulf of Mexico (Figure 1). The UNOLS vessel *RV Gyre* was contracted to support this work. The work took place in about 1,300 m water depth through a 4 km transect at lat. 27.9356°N, lon. 89.2794°W (lease block Atwater Valley 14); coordinates are listed in Table 2. Total sampling included mounds D and F and a transect between the mounds. Previous USGS seismic lines AV65, AV97 and AV82 and a 3.5 kHz echosounder profile collected during the cruise were used to guide operations (Figure 2). These seismic data were used because the NRL DTAGS system planned for the cruise was not operational prior to departure from port. Data is available from a subsequent DTAGS operation on this site. Extensive piston coring and heatflow was conducted at mound F (Figures 3 & 4). Dense heat flow measurements and one piston core were obtained at mound D (Figures 3 & 5). All coring and heat flow measurements were conducted at the sites planned for deep drilling by

the Chevron-Texaco JIP. Data at these sites are compared in this report. Table 2 provides exact locations of the piston core and heat flow locations.

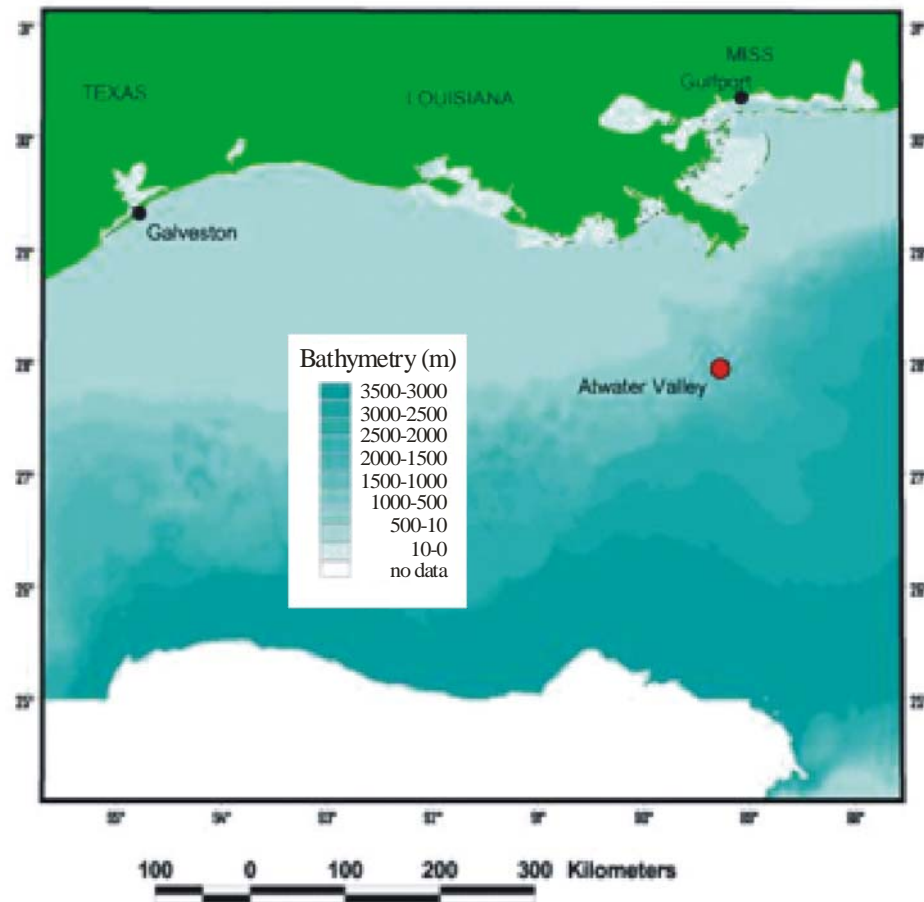


Figure 1: Atwater Valley location along the Texas-Louisiana Shelf in the Gulf of Mexico.

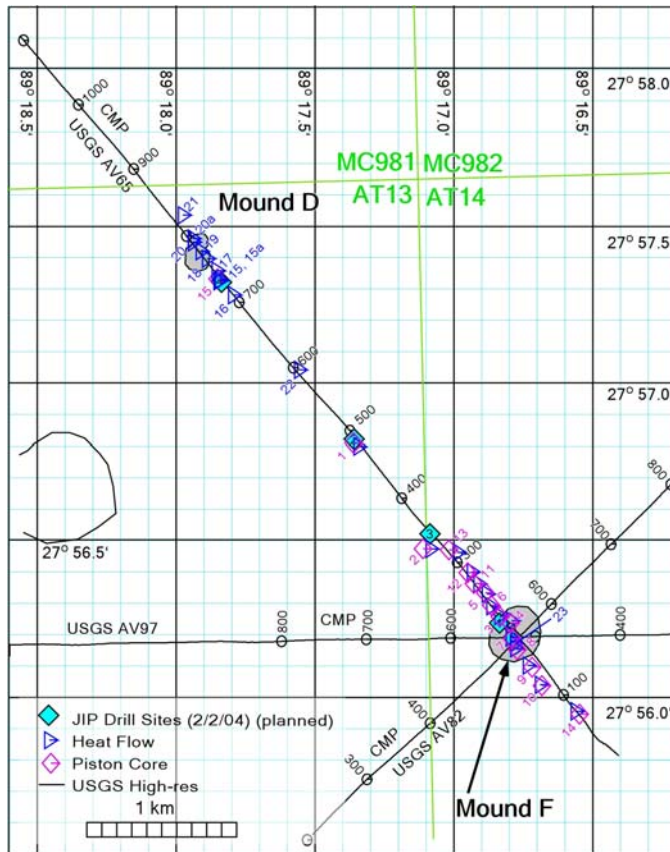


Figure 2: Piston core and heatflow sample positions on Atwater Valley.

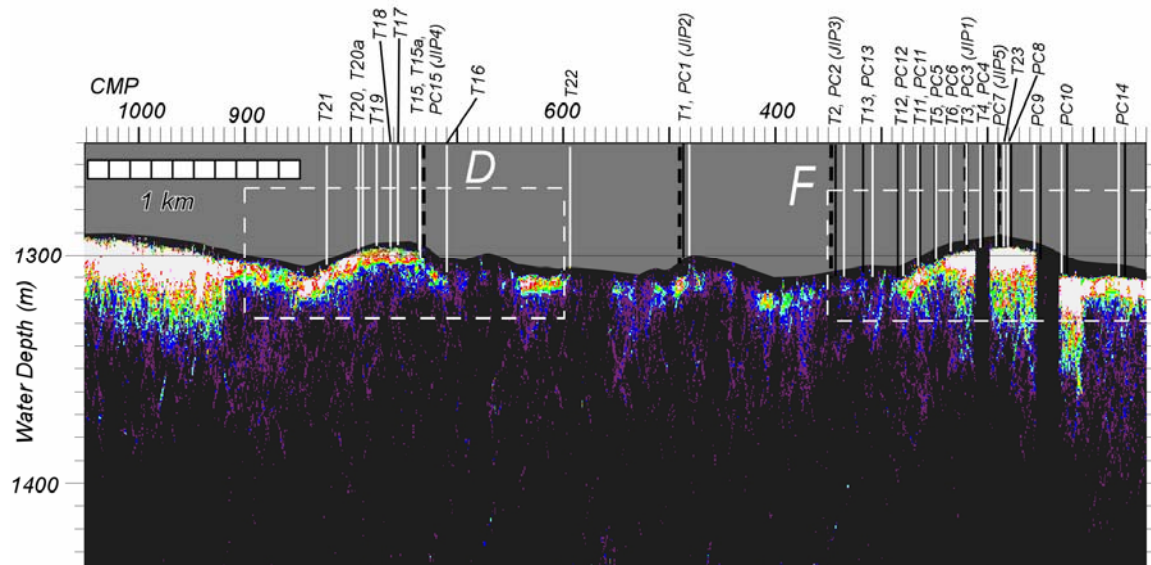


Figure 3: NRL piston core and heatflow transect sites presented over a 3.5 kHz transect through the sample region.

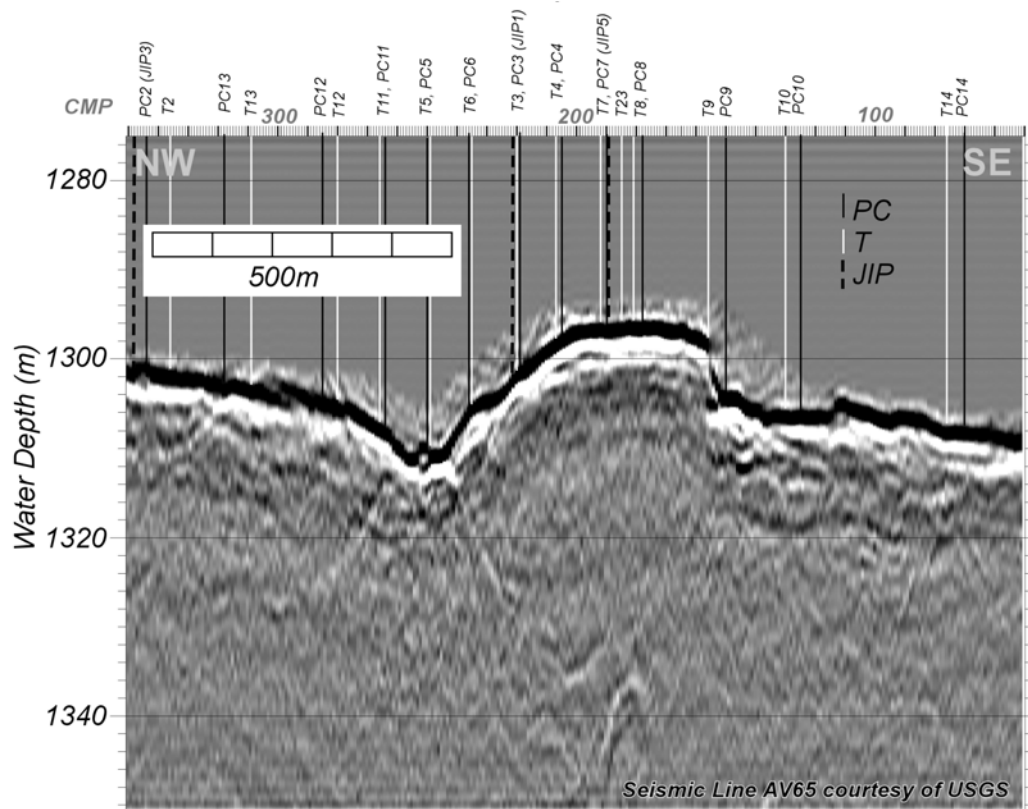


Figure 4. A portion of USGS multichannel seismic line AV65 over Mound F.

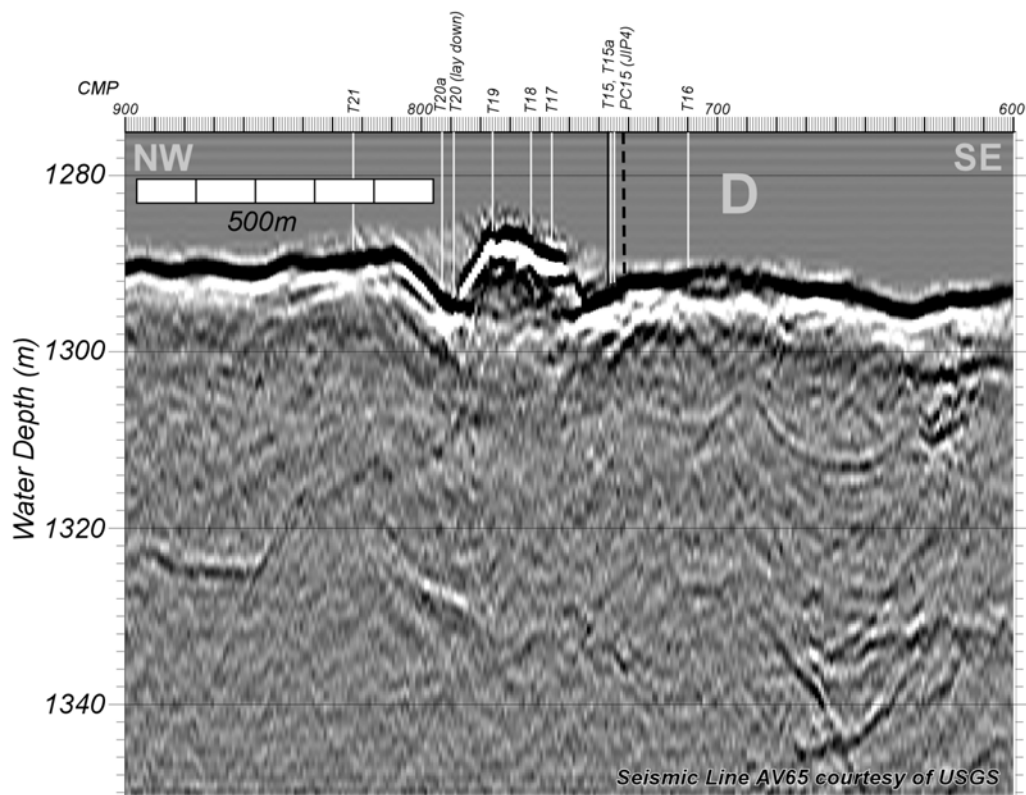


Figure 5. A portion of USGS multichannel seismic line AV65 over Mound D.

Table 2: Locations, water depths, and penetrations lengths of piston cores and thermal probe sites. CMP number refers to USGS seismic line AV65 acquired in April 2003. JIP sites 1-5 are planned sites for deep drilling. Chevron Texaco JIP focus site are listed under the sample column.

| SAMPLE | | | LAT | | | LON | av65 | LON | LAT | Water | Penet. |
|--------------|-----|-----|--------|-----|-----|--------|------|----------|----------|-----------|------------|
| P Core | Deg | Min | Sec | Deg | Min | Sec | Cmp | dec deg | dec deg | Depth (m) | Length (m) |
| PC 1 (JIP2) | 27 | 56 | 48.8 | 89 | 17 | 21.6 | 487 | 89.28933 | 27.94689 | 1292 | 2.70 |
| PC 2 (JIP3) | 27 | 56 | 28.644 | 89 | 17 | 6.629 | 344 | 89.28517 | 27.94129 | 1300 | 4.70 |
| PC 3 (JIP1) | 27 | 56 | 15.738 | 89 | 16 | 49.969 | 219 | 89.28055 | 27.93771 | 1301 | 3.70 |
| PC 4 | 27 | 56 | 14.534 | 89 | 16 | 47.732 | 205 | 89.27993 | 27.93737 | 1298 | 8.38 |
| PC 5 | 27 | 56 | 20.137 | 89 | 16 | 53.121 | 250 | 89.28142 | 27.93893 | 1310 | 3.46 |
| PC 6 | 27 | 56 | 17.797 | 89 | 16 | 51.937 | 236 | 89.28109 | 27.93828 | 1305 | 5.12 |
| PC 7 (JIP5) | 27 | 56 | 11.508 | 89 | 16 | 47.356 | 190 | 89.27982 | 27.93653 | 1296 | 8.67 |
| PC 8 | 27 | 56 | 9.514 | 89 | 16 | 46.247 | 178 | 89.27951 | 27.93598 | 1296 | 5.15 |
| PC 9 | 27 | 56 | 6.189 | 89 | 16 | 43.101 | 150 | 89.27864 | 27.93505 | 1304 | 4.36 |
| PC 10 | 27 | 56 | 2.437 | 89 | 16 | 40.942 | 125 | 89.27804 | 27.93401 | 1306 | 4.12 |
| PC 11 | 27 | 56 | 21.998 | 89 | 16 | 55.766 | 264 | 89.28216 | 27.93944 | 1307 | 4.76 |
| PC 12 | 27 | 56 | 24.084 | 89 | 16 | 56.983 | 285 | 89.2825 | 27.94002 | 1304 | 3.10 |
| PC 13 | 27 | 56 | 28.378 | 89 | 17 | 0.924 | 17 | 89.28359 | 27.94122 | 1302 | 3.47 |
| PC 14 | 27 | 55 | 56.881 | 89 | 16 | 32.79 | 70 | 89.27578 | 27.93247 | 1307 | 5.25 |
| PC 15 (JIP4) | 27 | 57 | 20.066 | 89 | 17 | 50.963 | 737 | 89.29749 | 27.95557 | 1292 | 3.40 |
| HEAT | | | | | | | | | | | |
| T 1 (JIP2) | 27 | 56 | 48.072 | 89 | 17 | 20.697 | 481 | 89.28908 | 27.94669 | 1292 | 3.00 |
| T 2 (JIP3) | 27 | 56 | 28.524 | 89 | 17 | 5.147 | 336 | 89.28476 | 27.94126 | 1301 | 3.00 |
| T 3 (JIP1) | 27 | 56 | 15.712 | 89 | 16 | 50.229 | 220 | 89.28062 | 27.9377 | 1302 | 3.00 |
| T 4 | 27 | 56 | 14.781 | 89 | 16 | 47.582 | 207 | 89.27988 | 27.93744 | 1298 | 3.00 |
| T 5 | 27 | 56 | 19.943 | 89 | 16 | 52.907 | 249 | 89.28136 | 27.93887 | 1310 | 3.00 |
| T 6 | 27 | 56 | 17.546 | 89 | 16 | 51.969 | 235 | 89.2811 | 27.93821 | 1305 | 3.00 |
| T 7 (JIP5) | 27 | 56 | 11.595 | 89 | 16 | 47.774 | 192 | 89.27994 | 27.93655 | 1296 | 3.00 |
| T 8 | 27 | 56 | 9.506 | 89 | 16 | 46.766 | 181 | 89.27966 | 27.93597 | 1296 | 3.00 |
| T 9 | 27 | 56 | 6.242 | 89 | 16 | 44.124 | 156 | 89.27892 | 27.93507 | 1298 | 3.00 |
| T 10 | 27 | 56 | 2.55 | 89 | 16 | 41.452 | 130 | 89.27818 | 27.93404 | 1306 | 3.00 |
| T 11 | 27 | 56 | 21.889 | 89 | 16 | 54.746 | 266 | 89.28187 | 27.93941 | 1307 | 3.00 |
| T 12 | 27 | 56 | 24.123 | 89 | 16 | 56.196 | 280 | 89.28228 | 27.94003 | 1305 | 3.00 |
| T 13 | 27 | 56 | 27.853 | 89 | 16 | 59.271 | 309 | 89.28313 | 27.94107 | 1303 | 3.00 |
| T 14 | 27 | 55 | 57.481 | 89 | 16 | 33.73 | 76 | 89.27604 | 27.93263 | 1307 | 3.00 |
| T 15 (JIP4) | 27 | 57 | 19.579 | 89 | 17 | 50.917 | 735 | 89.29748 | 27.95544 | 1293 | 3.00 |
| T 15a (JIP4) | 27 | 57 | 19.837 | 89 | 17 | 50.715 | 736 | 89.29742 | 27.95551 | 1293 | 3.00 |
| T 16 | 27 | 57 | 16.91 | 89 | 17 | 47.841 | 710 | 89.29662 | 27.9547 | 1291 | 3.00 |
| T 17 | 27 | 57 | 21.563 | 89 | 17 | 51.347 | 746 | 89.2976 | 27.95599 | 1288 | 3.00 |
| T 18 | 27 | 57 | 23.865 | 89 | 17 | 53.473 | 763 | 89.29819 | 27.95663 | 1287 | 3.00 |
| T 19 | 27 | 57 | 25.316 | 89 | 17 | 54.858 | 776 | 89.29857 | 27.95703 | 1287 | 3.00 |
| T 20 | 27 | 57 | 27.048 | 89 | 17 | 56.504 | 789 | 89.29903 | 27.95751 | 1294 | 3.00 |
| T 20a | 27 | 57 | 27.711 | 89 | 17 | 56.595 | 793 | 89.29905 | 27.9577 | 1293 | 3.00 |
| T 21 | 27 | 57 | 32.195 | 89 | 17 | 58.656 | 823 | 89.29963 | 27.95894 | 1289 | 3.00 |
| T 22 | 27 | 57 | 2.656 | 89 | 17 | 33.478 | 595 | 89.29263 | 27.95074 | 1293 | 3.00 |
| T 23 | 27 | 56 | 10.425 | 89 | 16 | 47.018 | 185 | 89.27973 | 27.93623 | 1296 | 3.00 |

4. Chronology

May 10-14 were spent at dock in Gulfport, MS mobilizing and waiting for DTAGS repair. By the afternoon of May 13, the decision was made to proceed with the piston coring and thermal probing portions of the cruise without DTAGS. In route a science meeting was held with Coffin, Gardner, Pohlman and Wood, at which the science plan was discussed and remaining on-site ship time allotted.

The RV Gyre arrived at the Atwater Valley site in the afternoon of May 14, the acoustic navigation transponder was deployed through the moon pool and one piston core was obtained before nightfall at JIP Site 2 (Figure 1). Piston cores 2-8 were acquired on May 15, and 9-15 were acquired on May 16. All deployments resulted in recovered samples, and all but PC1 and PC2 were acoustically navigated. The cable was re-rigged for the thermal probe at about 19:00, but because both winch operators were used all day in coring and were tired, thermal probe operations were postponed until morning.

The thermal probe was deployed at about 0900 May 17, three stations were acquired and the probe was brought up to download data, since no acoustic communication was available. Data were of good quality so the probe was redeployed this time for 5 stations, before being brought up to download data. Another deployment of 5 stations was acquired and the probe was brought on deck for charging overnight. These first 13 stations extensively sampled mound F.

On May 18 three more deployments resulted in 12 more stations (mostly over mound D) before science operations were ended at about 18:00, and preparations were made to transit to Galveston. All thermal probe sites were acoustically navigated. The return to Galveston required 37 hrs – the Gyre arrived in port about 08:30 May 20, 2004.

III. METHODS

1. Acoustic Navigation

On board the RV Gyre was a Sonardyne Fusion acoustic navigation system, consisting of a multi-element transceiver array (head) that was deployed through the moon pool via an hour long procedure requiring bolting the system to a bracket within the moon pool. Maximum speed with the transceiver deployed was 3.5 to 4 kts. A Sonardyne mini-transponder was the remote transponder, attached to the piston core cable 50 meters above the core head, and attached to the thermal probe cable 100 meters above the thermal probe weight stand. The vertical reference unit was fixed about 3 meters aft of the transponder, and all instruments were calibrated prior to the NRL personnel boarding the ship.

The acoustic tracking was largely successful but deeper than about 800 the position fix deteriorated significantly. This may be due to the transceiver being directed slightly aft, or possibly due to the relatively weaker signal from the mini-transponder as opposed to the full sized transponder for which the system was designed. The mini-transponder was used because the only cable clamps available would not fit the full sized transponder. Deeper than about 800 the fixes appeared better if the remote transponder was greater than about 20 meters aft of the ship.

When good position fixes were obtained, we estimate they were accurate to within about 2-5 meters.

2. Piston Coring

Piston coring (PC) was conducted over the starboard side of the vessel. PC was conducted on a 24 hour basis. Because objectives include the recovery of methane hydrate, which melts very quickly when on deck, care was taken to quickly place the PC apparatus on deck, disassemble the core barrels, and inspect for samples before the samples melt. Because hydrogen sulfide fumes can be present in these areas all disassembly were outside, on deck, and all crew working with the PC were briefed on safety procedures. All PC stations planned were in about 1300 m of water, so at 60 meters per minute, transit time was about 22 minutes. Station locations (way points) for piston coring and heat flow were planed over Mounds D and F and through transects between the sites.

3. Pore Water

a. Press Loading and Squeezing - Whole round core sections were transported to the lab. Clean dry spatulas were used to scrape the surface sediment from the core and the surface material was discarded. Sediment from the interior of the core were scooped out and placed inside the body of the press. The press bodies were filled with sediment to maximum capacity in order to leave a minimum volume of air. A clean dental dam was place on the air inflow side of the press body to prevent free airflow through the core. The press bodies were capped and placed on the pore water press rack. Pore water was collected in a 60 ml syringe on the outflow line. Pressure through the line was constant with nitrogen gas. Sediment from the press was placed on a sheet of ashed Al foil and frozen.

b. Pore water Processing - Pore water fluid was extracted with a pressurized pore water sampler from 10-cm whole round core sections collected every 25-45 cm. A minimum of 7 mls pore water per sample was required. Using the side port on a three-port stopcock, 1 ml was removed from the 60 ml syringe with a 10 ml syringe for analysis of total sulfides. A 0.2 μm syringe filter and a 21 gauge needle was placed on the 60 ml syringe. The contents of the syringe were placed into a scintillation vial. Using a 1 ml fixed volume pipet, 2 mls (exactly) of the sample were transferred into the serum vial for DIC concentration. Vials were sealed with septa immediately and 2-3 mls were transferred into the serum vial for $\delta^{13}\text{C}$ -DIC. The rest of the vial was filled with N_2 sparged water. About 0.5 mls of headspace was left in the vial. Vials were sealed with Teflon septa immediately. 2 mls were transferred into the screw top vial for the ion analysis (SO_4^{2-} and Cl^-). The ion samples were refrigerated and DIC samples were frozen.

4. Ship Board Laboratory Analysis

a. Sulfate and Chloride Concentrations – Sulfate and chloride were measured with a Dionex DX-120 ion chromatograph equipped with an AS-9HC column. Samples were diluted 1:50 (vol/vol) prior to analysis and measured against a 1:50 diluted IAPSO standard seawater (28.9 mM SO_4^{2-} , 559 mM Cl^-). Concentrations were measured in pore waters of sediments from the

piston cores to assist in the prediction of hydrate beds below. For the estimation of the pore water sulfate methane interface (SMI) vertical sulfate profiles were plotted to observe the depth at which concentrations were measured below the ion chromatography limits of detection (<0.1 mM). The SMI is estimated to be the depth of the final measured concentration plus half the depth to the next section that pore water was sampled. For cores that sulfate profiles were not measured at zero the linear line for the decline in sulfate profiles was predicted to the t-intercept to estimate the SMI depth. Sulfate and chloride were measured against an IAPSO seawater standard and are presented in millimolar units (mM).

b. Pore Water Methane Concentrations - Methane concentrations were determined from 3-ml sediment plugs using headspace techniques and were quantified against certified gas standards (Scott Gas, Plumbsteadville PA). Headspace analysis was performed on board using a GC-FID Shimadzu GC-14A gas chromatograph equipped with a Hayesep 0.80/100 column. Methane concentrations are presented in millimolar units (mM).

c. Sulfide concentrations - Pore water sulfide concentrations were measured with a Turner spectrophotometer, using the Cline method (Cline, 1969). Sulfide concentrations are presented in millimolar units (mM).

5. Laboratory Analysis

a. Carbon Isotope Analysis - Stable carbon isotope ratios were measured on methane from gas pockets and pore water DIC. Radiocarbon analysis was performed on bulk sediment organic matter from select cores. For stable carbon isotope ($\delta^{13}\text{C}$) analysis, gases were analyzed with a Finnigan Delta S Isotope Ratio Mass Spectrometer with a sample injection through a Varian GC. For DIC, carbon dioxide was released into the headspace were by adding 100 μl of 10% HCl into the sample serum vial. Methane was oxidized to carbon dioxide prior to its introduction into the IRMS. Solid samples were analyzed using a CN combustion instrument with He carrier gas flowing into the isotope ratio mass spectrometer. For radiocarbon isotope analysis ($\Delta^{14}\text{C}$) samples in different carbon phases are combusted or acidified to CO_2 and concentrated in a cryogenic distillation line. The trapped CO_2 is converted to graphite for AMS analysis on the NRL system. Carbon dioxide was cryogenically purified and reduced to graphite at 575 $^\circ\text{C}$ in a hydrogen atmosphere using an iron catalyst. $\delta^{13}\text{C}$ and $\Delta^{14}\text{C}$ analysis is applied to trace the variation in sources, where the values are calculated as:

$$\delta^n C = \left[\frac{R_s}{R_{std}} - 1 \right] \times 1000 \text{ (‰)} \text{ (Eq. 1)}$$

where δ^n is the stable carbon isotope ratio, R is the $^{13}\text{C}/^{12}\text{C}$ for stable carbon $^{14}\text{C}/^{12}\text{C}$ for radiocarbon, s is the sample and std is the standard. For $\delta^{13}\text{C}$ analysis the standard is PeeDee Belmenite. For $\Delta^{14}\text{C}$ the standards are oxalic acid and ^{14}C dead coal. Radiocarbon was measured by AMS and is reported in the standard “per-mil” notation.

b. Pore Water DIC Concentrations - Pore water dissolved inorganic carbon (DIC) concentrations were measured using a UIC coulometer and standardized against a certified

reference material (CRM, Batch 58). DIC concentrations are presented in millimolar units (mM).

6. Heat Flow

High resolution heat flow data profiles were collected, processed and interpreted. NRL's telemetering marine heat-flow probe system, which was designed and built by the Geological Survey of Canada, measures temperature gradients and in-situ thermal conductivity of sediments both in lakes and coastal areas (water depth in 100's of metres) and in the deep ocean (water depths to 6000 metres). The length of probe was selected according to the "stiffness" of the sediments under investigation. NRL's probe is 3.5 meters long, penetrations were generally 3 meters. Temperatures and temperature gradients within the sediment were measured by thermistors that are located at known (30 cm) spacing within a small-diameter tube held in tension parallel to a solid steel strength member. Measurement of the thermal conductivity of the sediment was accomplished by allowing the probe to remain at rest in the sediment (typically for a period of 7 minutes) to allow dissipation of the frictional heating generated by the penetration of the probe, and then heating the probe and surrounding sediment by application of a known amount of energy (typically 600 joules/metre) to a heater wire paralleling the thermistors within the sensor tube. Analysis of the temperature decay following this period of energy input (or "heat pulse") yielded the conductivity of the sediment. Operation with a heat pulse at a study site took approximately 20 minutes.

Other parameters in addition to the temperatures in the probe were also logged. These include: pressure (water depth), water temperature, tilt, a stable reference resistance, and time. All parameters were logged in solid state memory.

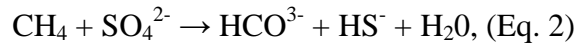
The probe was lowered at the beginning of a working day. After making a penetration into the sediments for thermal gradient measurements (and possibly a conductivity measurement), the probe was raised clear of the bottom and moved to the next site for another penetration. The probe was returned to the surface to download data after every third station. The probe continues to perform in this manner for a typical period of 12 hours, with operation during day light hours.

IV RESULTS

1. Piston Coring Geochemical Profiles

Field work commenced with piston coring to facilitate station selection and ensure heatflow probe penetration without damage. Coring site selection was intended to provide high resolution sulfate, methane, chloride, dissolved inorganic carbon, and DIC stable carbon isotope ratio data on and between mounds D and F. A combination of seismic data, heatflow profiles and pore water geochemistry data was utilized to predict regions that are abundant in deep sediment gas hydrates. Data from the seismic surveys is presented in the General Information section of this report. The geochemical and heatflow data will also be compared with the NRL DTAGS seismic survey planned for February 2005. Geochemical profiles are compared through the study region and then grouped according to the Chevron-Texaco JIP sites planned for investigation in Spring 2005.

Parameters for the pore water data include methane, sulfate, chloride and dissolved inorganic carbon concentration and stable carbon isotope ratio. Pore water geochemical data are plotted for comparison of methane and sulfate concentrations to assess the varying degrees of vertical methane fluxes and resulting methane oxidation (Borowski et al., 1999). Anaerobic methane oxidation occurs as:



in sediment depths were vertical flow of deep sediment methane and shallow sediment sulfate converge; i.e., sulfate-methane interface (SMI). This analysis is used to estimate the presence of methane deep in the sediments to provide an indication of gas hydrate potential. Dissolved inorganic carbon (DIC) is included to support the interpretation of methane oxidation to CO_2 by the anaerobic oxidation of methane (AOM). Stable carbon isotope analysis of the DIC provides additional interpretation of methane oxidation and contribution to the DIC pool. In biological oxidation of methane there is a difference in the enzyme activity in oxidation of ^{12}C and ^{13}C , where the rate for ^{12}C is more rapid and creates ^{13}C depleted stable carbon isotope signatures. Chloride data was originally incorporated to trace segments of the piston cores that contained hydrates with the assumption that chloride concentrations decrease in sections of the core that have dissociated hydrates through dilution by salt free melted hydrate. An alternate interpretation of the chloride data is presented below.

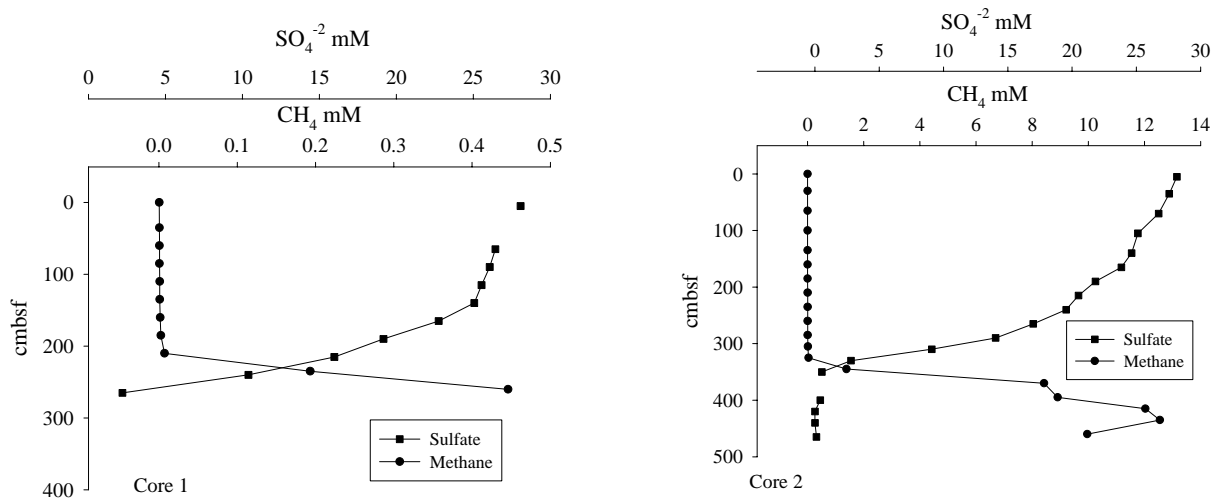


Figure 6: Piston core CH_4 and SO_4^{2-} profiles of stations located between the USGS seismic survey observation of mound D and mound F. Vertical profiles are presented as centimeters below sea floor (cmbsf).

Sulfate and methane data presented in the following figures are intended to provide an overview of the pore water profiles through the study region. The total data set is presented in Appendix 1. Based on data from the seismic survey Core 1 and Core 2 were selected as a control region in which low heatflow and gas flux were anticipated (Figure 6). The SMIs, estimated

from the sulfate profiles for Cores 1 and 2 were measured at 288 cm to 410 cm, respectively. Core 1 had lower methane concentrations, but the core was short and likely did not penetrate to a depth below the SMI. Sulfate gradients indicate a substantial methane flux. Core 2 penetrated the SMI and displays co-variation in methane and sulfate typical of cores with moderate gas flux.

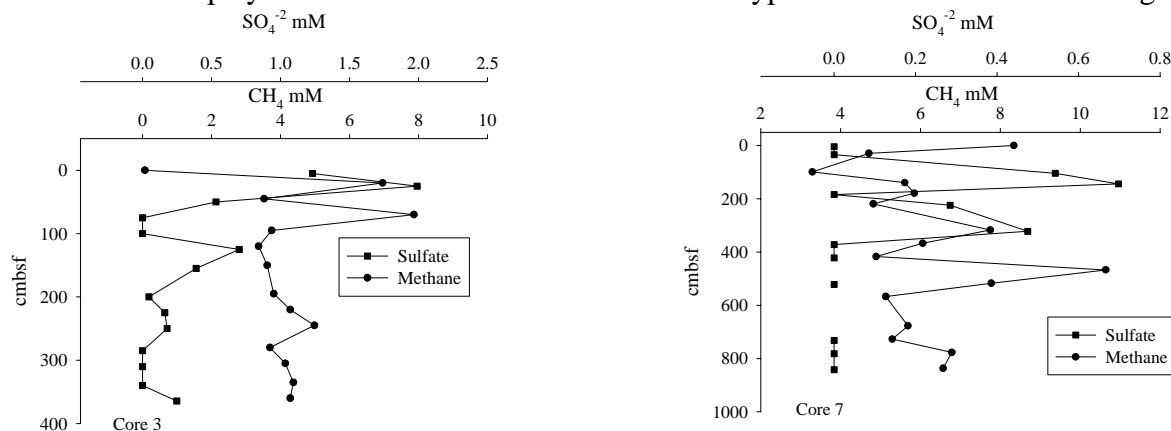


Figure 7: Piston core CH_4 and SO_4^{2-} profiles of stations located on mound F that was identified on a USGS seismic survey. Vertical profiles are presented as centimeters below sea floor (cmbsf).

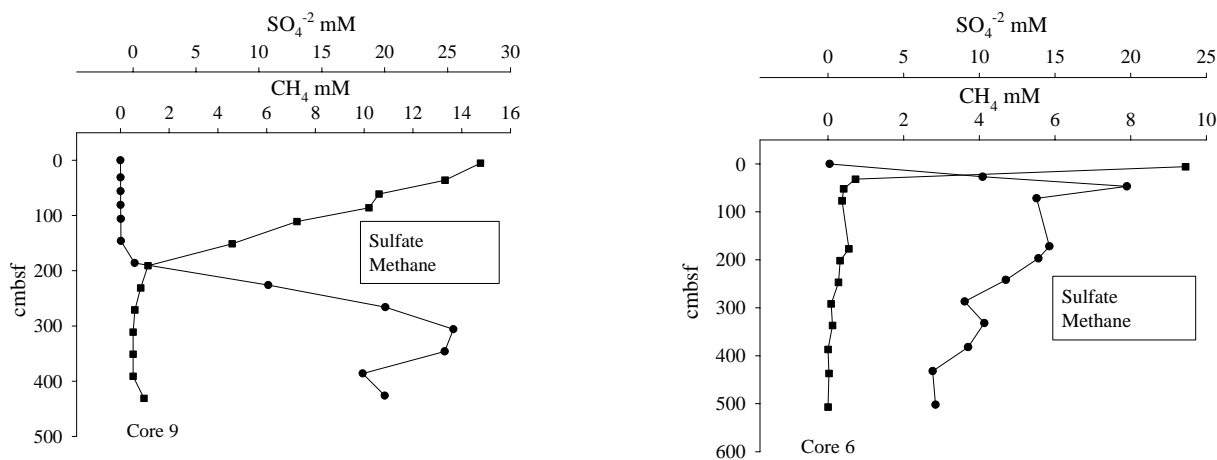


Figure 8: Piston core CH_4 and SO_4^{2-} profiles of stations located to the north (core 6) and south (core 9) of mound F. Vertical profiles are presented as centimeters below sea floor (cmbsf).

Piston cores 3 and 7 were located on top of mound F (Figure 7). There was a remarkable difference in the pore water methane and sulfate profiles relative to Cores 1 and 2. In both cores sulfate was depleted near the sediment-water column interface. The range in sulfate concentrations was 0 to 0.70 mM for core 7 and 0 to 1.99 mM for core 3. Corresponding methane concentrations were elevated with values through the pore water profiles ranging from 3.29 to 10.6 mM for core 7 and 0.07 to 7.9 mM for core 3. The upward vertical flux of methane in these cores exceeds the downward flux of sulfate required to quantitatively oxidize the methane within the sediments. SMI depths in these cores were extremely shallow and likely extends to the sediment water interface.

Piston cores 6 and 9, located at the edge of the mound, displayed intermediate fluxes relative to the cores previously discussed. The SMI was estimated to be 45 cm for core 6 and 251 cm for core 9 (Figure 8).

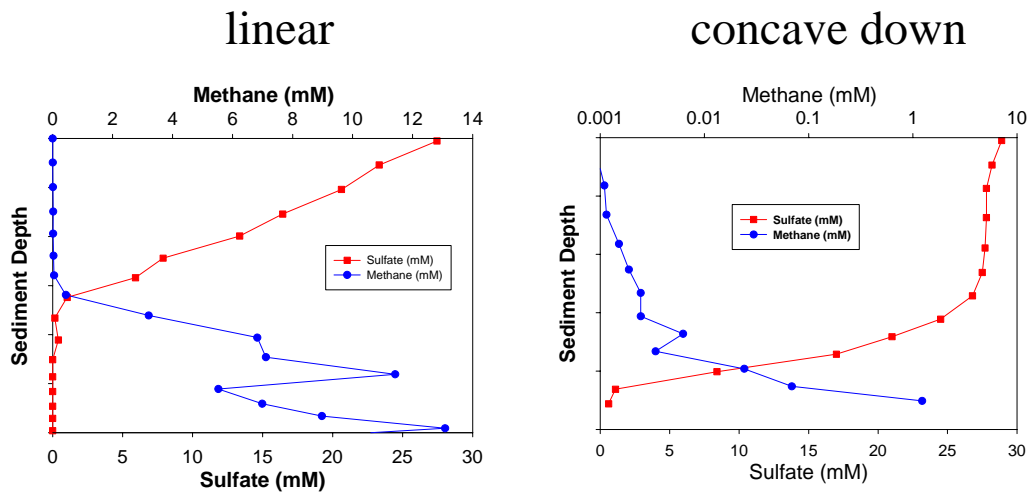


Figure 9: Example of piston core pore water data applied to predict deep sediment methane.

Pore water profiles of dissolved chemical constituents (in particular, sulfate) are useful for evaluating the biogeochemical conditions, gas flux and depositional history of a site. Under steady state conditions with high gas flux, “linear” sulfate profiles result due to diffusion and the anaerobic oxidation of methane (AOM) at the sulfate-methane interface (Figure 9). An alternate sulfate profile is a “concave down” concentration gradient (Figure 9). This type of curvature can result from changes in gas flux, downward vertical fluid advection, bioturbation or rapid sediment deposition. Non-linear profiles are transient features that will re-equilibrate once the perturbation ends. Sulfate profiles from piston cores on Atwater Valley sites were consistently concave down. Radiocarbon isotope analysis of the organic carbon from the cores will be used to assist in the interpretation of this profile shape.

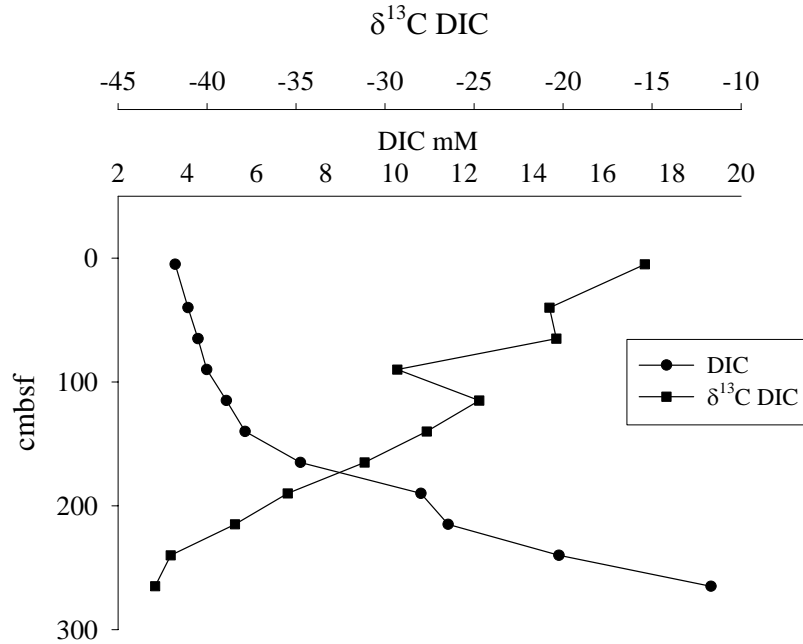


Figure 10: DIC concentration and $\delta^{13}\text{C}$ of DIC for Core 1 located in the center of the transect through Atwater Valley site between mound D and mound F. Vertical profiles are presented as centimeters below sea floor (cmbsf).

The concentration and $\delta^{13}\text{C}$ of pore water DIC mirrored the sulfate and methane data. Where there was depletion in the methane and sulfate pore water concentration, an increase in the DIC concentration and decrease in the $\delta^{13}\text{C}$ -DIC was observed. The control region, Core 1 had a deeper (but lower amplitude) increase in DIC concentration and decrease in the DIC $\delta^{13}\text{C}$ isotope signature (Figure 10). For core 7 the peak DIC concentration was 12.05 mM at 34 cm and core 2 was 19.54 mM at 340 cm. DIC concentration increases and $\delta^{13}\text{C}$ decreases ranged between 34 to 330 cm for cores 7 and 2, respectively (Figure 11). The differences noted between Cores 7 and 12 is due to higher rates of AOM in Core 7. The high shallow increases in the DIC concentration and depleted DIC $\delta^{13}\text{C}$ were dominant over mound F.

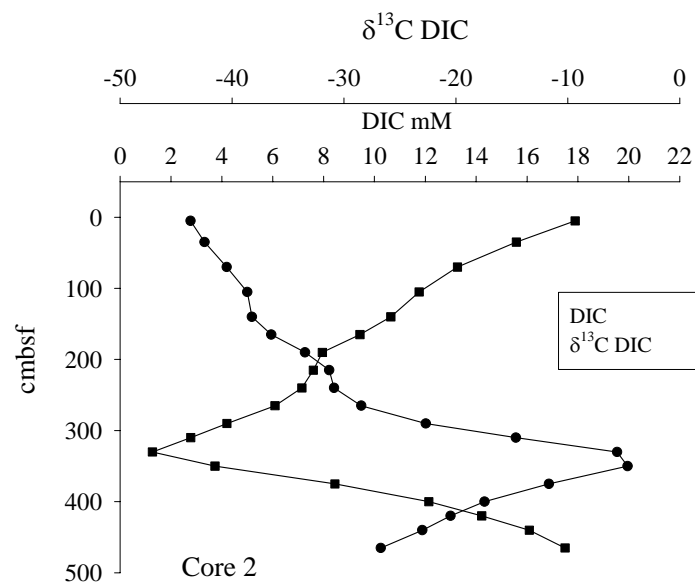
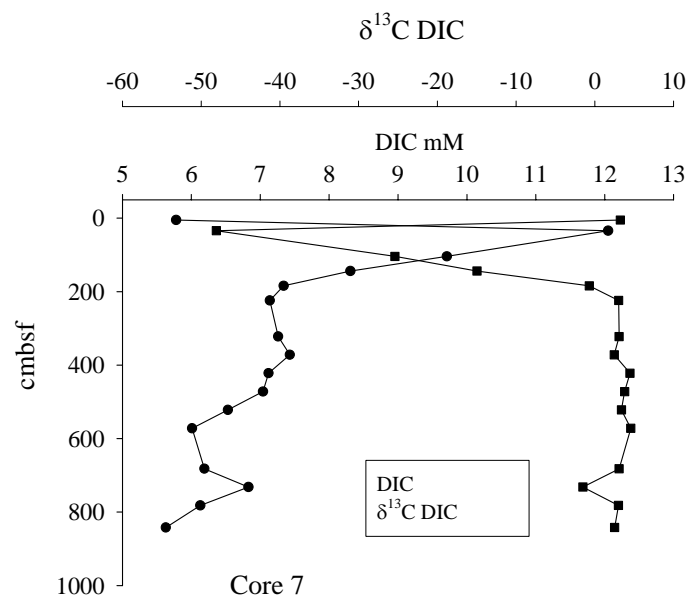


Figure 11: DIC concentrations and $\delta^{13}\text{C}$ of DIC for Core 7 and Core 2 present the range in profiles taken during the Atwater Valley survey. Vertical profiles are presented as centimeters below sea floor (cmbsf).

Pore water chloride concentrations were measured to provide an indication of dissociated gas hydrates. Chloride concentrations below seawater (559 mM) indicate hydrates may have dissociated and diluted the pore water. Among the 15 cores we analyzed (Figure 12), pore water freshening was observed in one sample from one core (Core 9). Instead, chloride concentrations higher than seawater were measured in many of the cores. Cores distal to mound F had background chloride concentrations, (e.g. cores 1, 2, 5, 9, 10, 12, 13, 14 and 15). Intermediate

chloride concentrations were observed in cores 6, 11 and 8 (near and on mound F). The highest chloride concentrations were observed in Cores 3, 7 and 4, which were collected directly over the mound. This trend indicates a vertical flux of fluid affected by the deeper salt diapers. This interpretation is consistent with that based on the sulfate and methane data described previously and the heatflow data presented below.

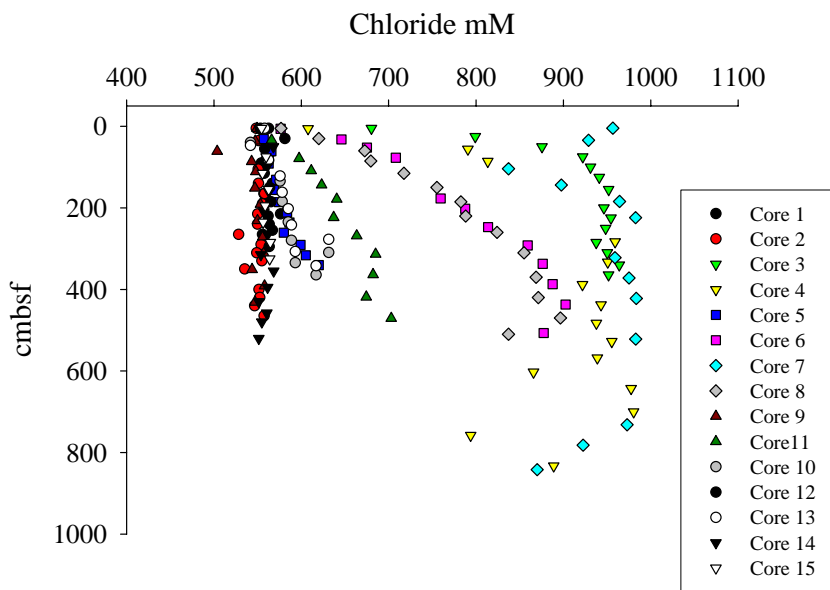


Figure 12: Chloride profiles for piston core pore water samples. Vertical profiles are presented as centimeters below sea floor (cmbsf).

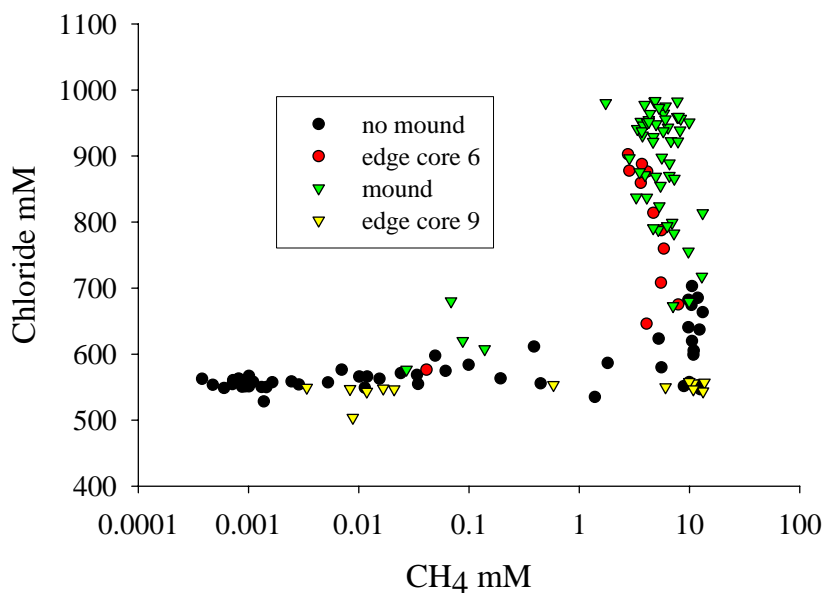


Figure 13: Comparison of pore water methane and chloride concentrations from cores on top of, on the edge and away from mound F. Vertical profiles are presented as centimeters below sea floor (cmbsf).

Further analysis of chloride shows a large variation relative to pore water methane concentrations (Figure 13). Cores from mound F had a high concentration of methane and chloride in pore water samples, while cores off the mound had typical background chloride with a large range in the methane concentrations; some samples with concentrations as high as values measured on mound samples. Cores 6 and 9 were located at the edge of the mound and were diverse in the pore water methane and chloride concentrations; core 9 data was similar to coring sites off the mound and core 6 data was similar to cores taken from the mound. This result suggests that regions with a high vertical flow of methane and chloride are sites where the pore water chloride, from the salt mounds, decreases the hydrate stability and increases the pore water methane concentration. This observation will assist in data interpretation and deep core drilling site selection by the Chevron-Texaco JIP program in this region.

Table 3: Core gas methane $\delta^{13}\text{C}$ data. Additional information includes vertical location of the gas pocket in the core, gas retention time (Rt) in the GC run and the area for the mass 44 peak. Standard deviations were calculated for samples from 180 cm in core 3 and 567 cm in core 7.

| Core | Corrected distance from top of core (cm) | Component | Rt | $\delta^{13}\text{C}$ | Area 44 | average | stdev |
|------|------------------------------------------|-----------|-------|-----------------------|---------|----------|----------|
| 3 | 180 | CH4 | 121.8 | -72.373 | 66.049 | -72.4623 | 0.098521 |
| 3 | 180 | CH4 | 122.1 | -72.568 | 19.279 | | |
| 3 | 180 | CH4 | 122.7 | -72.446 | 18.605 | | |
| 3 | 203 | CH4 | 122.3 | -71.956 | 17.222 | | |
| 3 | 222 | CH4 | 122.3 | -72.429 | 11.221 | | |
| 3 | 246 | CH4 | 122.3 | -72.077 | 21.241 | | |
| 4 | 615 | CH4 | 121.8 | -71.104 | 15.528 | | |
| 4 | 670 | CH4 | 122.3 | -71.323 | 20.165 | | |
| 4 | 715 | CH4 | 122.3 | -71.84 | 15.042 | | |
| 6 | 309 | CH4 | 122.3 | -63.736 | 14.755 | | |
| 6 | 321 | CH4 | 122.3 | -67.984 | 12.113 | | |
| 7 | 567 | CH4 | 121 | -71.206 | 40.998 | -71.272 | 0.088831 |
| 7 | 567 | CH4 | 122.7 | -71.373 | 19.641 | | |
| 7 | 567 | CH4 | 122.1 | -71.237 | 19.558 | | |
| 7 | 742 | CH4 | 122.3 | -69.224 | 24.168 | | |
| 8 | 240 | CH4 | 122.5 | -65.842 | 13.261 | | |
| 8 | 275 | CH4 | 122.1 | -70.851 | 21.197 | | |
| 8 | 362 | CH4 | 122.7 | -72.271 | 24.419 | | |
| 9 | 400 | CH4 | 122.1 | -79.878 | 15.662 | | |
| 11 | 242 | CH4 | 122.5 | -68.964 | 14.067 | | |
| 11 | 372 | CH4 | 122.3 | -76.418 | 17.152 | | |

Gas from the expansion cracks in the core liner was microbial in origin. Table 3 presents gas samples obtained from cores 3, 4, 6, 7, 9, and 11. The $\delta^{13}\text{C}$ of the methane ranged from -79.88‰ to -63.74‰. The variation suggests different degrees of microbial methane production and oxidation in the sediments and/or slight inputs of from thermogenic sources. Trace quantities of propane were detected in several cores. The average methane/ethane ratio for all

pore water was 866. These data are also consistent with a microbial gas origin with a possible slight contribution from a thermogenic source. Further understanding of variation in $\delta^{13}\text{C}$ of the methane will be accomplished with analysis of pore water methane and DIC.

2. Data Comparison of Chevron-Texaco JIP sites

One of the missions for this research cruise was to provide baseline data for the Chevron-Texaco JIP hydrate deep drilling plans on Atwater Valley. Fieldwork was designed to combine seismic, heatflow and piston coring data at the planned drilling sites. Piston cores 3, 1, 2, 15 and 7 corresponding, respectively, to the JIP sites 1, 2, 3, 4, and 5 are compared to pore water profiles in the following data presentation. The JIP sites 1 and 5 were located on mound F, JIP 2 and 5 were on the transect line between mounds D and F, and JIP 4 was on mound D.

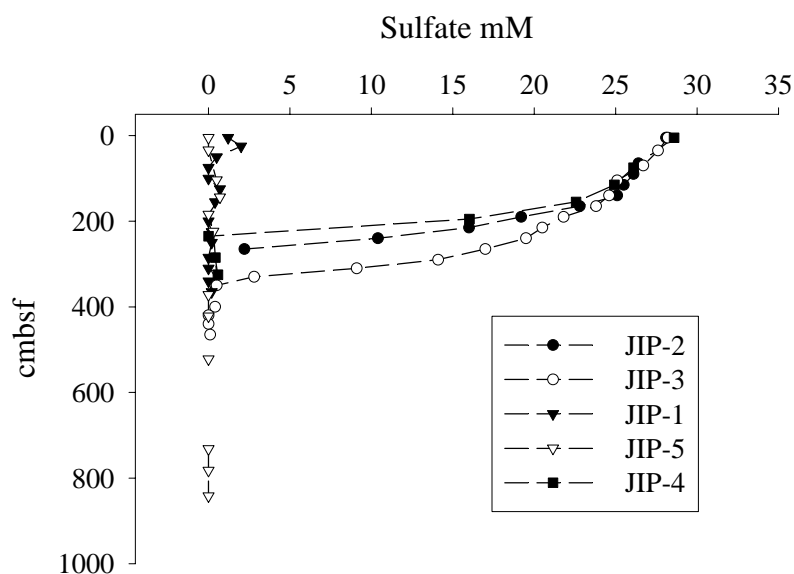


Figure 14: Pore water sulfate concentration profiles plotted relative to centimeters below the sea floor (cmbsf) for JIP sites along the Atwater Valley transect between mounds D and F.

Pore water sulfate concentrations were divided in two distinct profiles for the JIP sites (Figure 14). Sulfate was depleted through the piston cores at JIP-1 and JIP-5, suggesting anaerobic oxidation of methane and reduction of sulfate at the sediment-water column interface. Sulfate penetrated deeper at JIP-2, JIP-3 and JIP-4. For these cores the SMI ranged from 218 cm to 410 cm (Appendix 1). The JIP-1 and JIP-5 stations, on mound F, appear to have the highest methane flux.

Pore water methane concentrations matched the sulfate profiles measured in the JIP stations (Figure 15). At JIP-1 and JIP-5, on mound F, methane concentrations were high through the vertical profile to the water column-sediment interface, ranging from 0.1 mM to 10.6 mM, with an average of 5.3 mM. At JIP-2, JIP-3 and JIP-4 methane profiles were depleted from approximately 300 cm to the sediment surface and averaged 1.5 mM. The high concentrations are a result of the high methane flux, with sulfate concentrations that did not provide an electron acceptor in the anaerobic oxidation of methane.

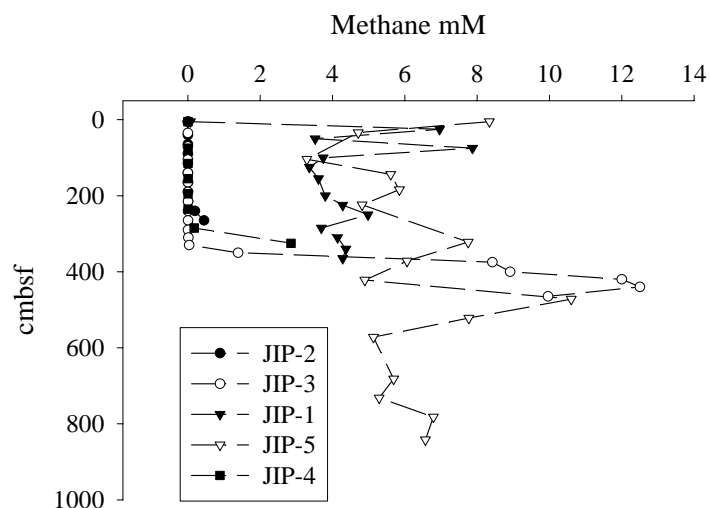


Figure 15: Pore water methane concentration profiles plotted relative to centimeters below the sea floor (cmbsf) for JIP sites along the Atwater Valley transect between mounds D and F.

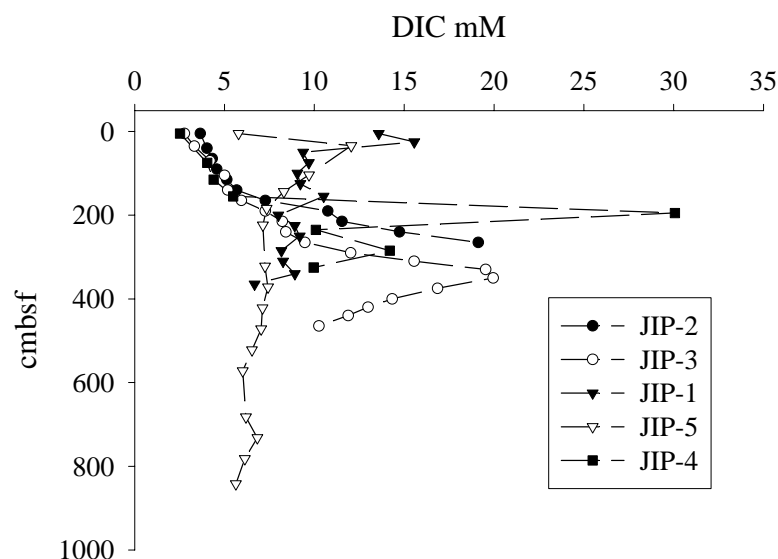


Figure 16: Pore water DIC concentration profiles plotted relative to centimeters below the sea floor (cmbsf) for JIP sites along the Atwater Valley transect between mounds D and F.

Pore water DIC profiles are presented in Figure 16. Surface concentrations, above 200 cm in these two locations are distinctly different. JIP-1 and JIP-5, which are located on top of mound F, have greater concentration, ranging between 2.8 mM and 15.6 mM. The other three locations were found to be at concentrations that were less than 5 mM. Higher concentrations on the mound correspond to the methane and sulfate profiles at these sites which indicate high methane vertical flow and active anaerobic methane oxidation.

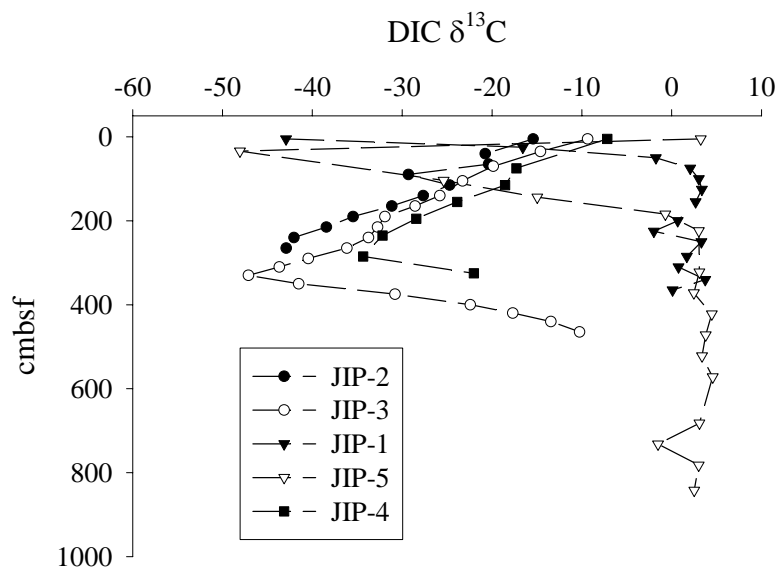


Figure 17: Pore water dissolved inorganic carbon concentration profiles plotted relative to centimeters below the sea floor (cmbsf) for JIP sites along the Atwater Valley transect between mounds D and F.

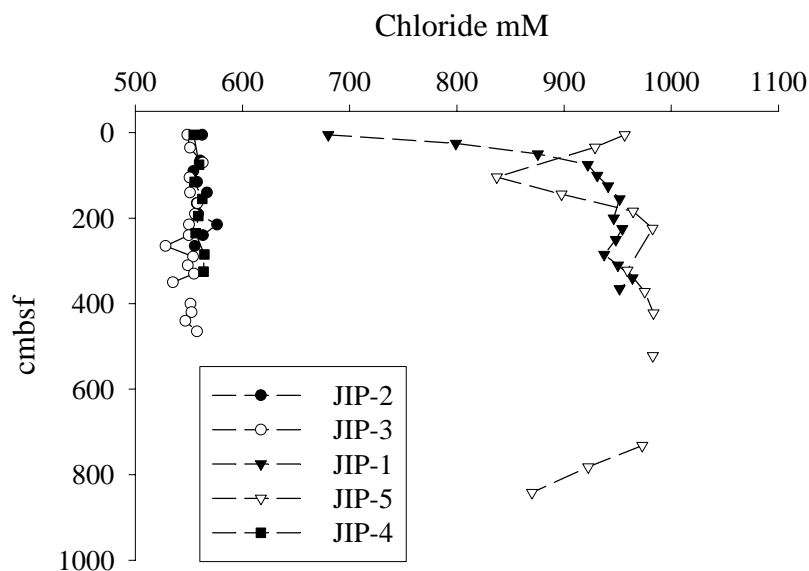


Figure 18: Pore water chloride concentration profiles plotted relative to centimeters below the sea floor (cmbsf) for JIP sites along the Atwater Valley transect between mounds D and F.

Stable carbon isotope analysis of the pore water DIC is used for further explanation of the methane cycling (Figure 17). With higher vertical methane flow on mound F at the JIP-1 and JIP-5 locations, there are ^{13}C depleted isotope signatures which indicate active anaerobic oxidation of methane. The ^{13}C -depleted signatures at JIP-2, JIP-3 and JIP-4 are deeper in the piston cores, suggesting less methane flux in regions, relative to JIP-1 and JIP-5.

Chloride concentrations at the JIP sites do not show significant decrease from values ranging around 550 mM (Figure 18). In contrast, the JIP-1 and JIP-3 sites on mound F are enriched in chloride. These data suggest high salt diffusion in pore water from salt diapirs below the mound.

C. Heatflow Survey

Heat flow measurements were made along the NW-SE USGS seismic line that crossed both mound D and mound F. With the exception of HF4 and HF7, located on the summit of mound F, the thermistors at depths of less than about 1 meter recorded equilibrium sediment temperatures that deviate significantly from the expected linear trend (Figures 19 and 20). The cause of this curvature in the temperature profile, with shallow temperatures warmer than expected, is unknown, but could result from a recent spurt of increased sedimentation or a recent slight (0.05 degrees C) increase in bottom water temperature. Increased sedimentation could be in the form of a thin recent slump deposit or turbidite. Abrupt temperature changes could occur beneath the warm eddies that are periodically spun off by the Gulf Loop Current and drift westward across the northern Gulf (Hamilton, 1990). These eddies are known to affect bottom circulation patterns in this area (Hamilton, 1990).

Heat flow values were determined at each station by computing thermal resistance values at each thermistor,

$$R = \int (1/\lambda) dz, \text{ (Eq. 3)}$$

where λ is the thermal conductivity. In a situation of steady-state conductivity the heat flow is equal to the slope of the line on a Bullard Plot, a plot of temperature vs. thermal resistance. For each station, the non-linear data from depths of less than 0.9 meters was removed, and the heat flow value determined from the slope of the best-fitting linear least-squares line through the remaining data. All heat flow values were corrected for instrument tilt (all tilt values were less than 5.4 degrees, requiring corrections of less than 0.45%).

The data show clear anomalies in sediment temperature and heat flow associated with the mounds. Measurements collected on the top of mound F show elevated sediment temperatures, and heat flow values of around 160 mW/m². Sediment temperatures decrease away from the summit of the mound, and heat flow values drop to a background level of 40 to 50 mW/m² (Figures 20 and 21). Sediment temperatures at the summit of mound D are similar to what was observed at mound F, and heat flow values are slightly lower at around 132 mW/m², partly as a result of the slightly higher bottom water temperature and thus reduced thermal gradient. Away from the summit of mound D the thermal gradient decreases and heat flow values drop to around 50 mW/m².

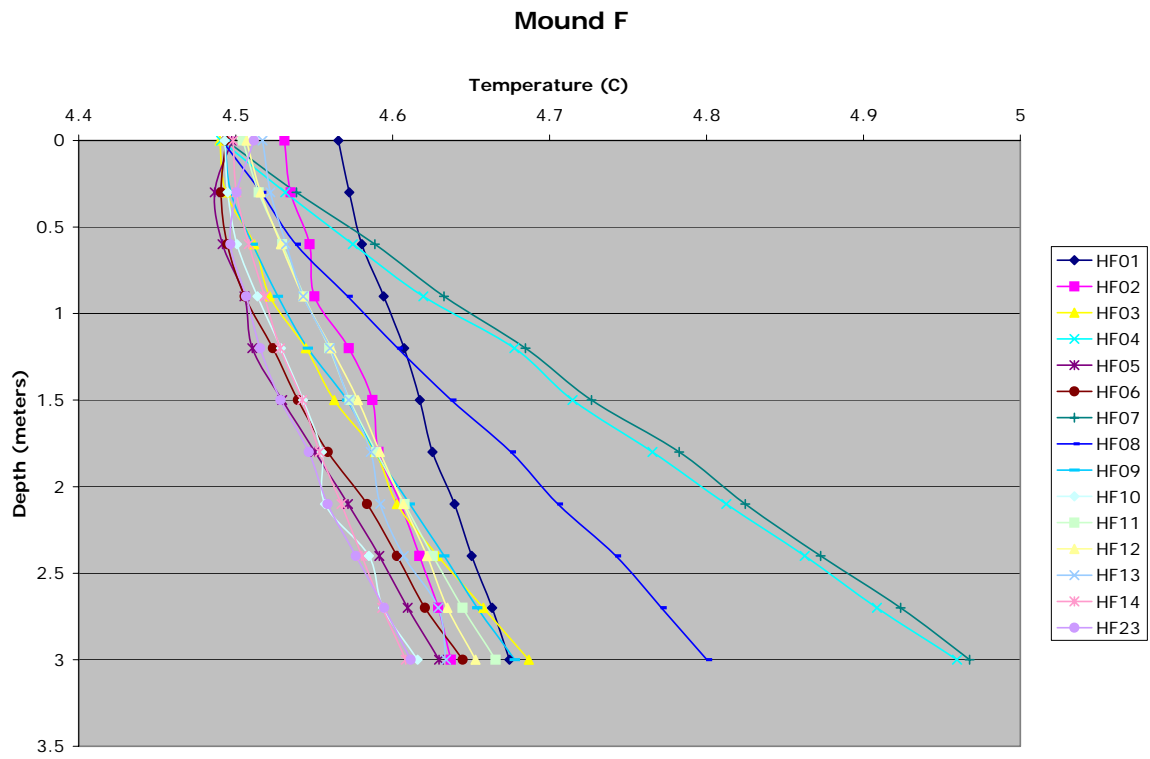


Figure 19: Temperature vs. Depth plots for stations along transect over Mound F.

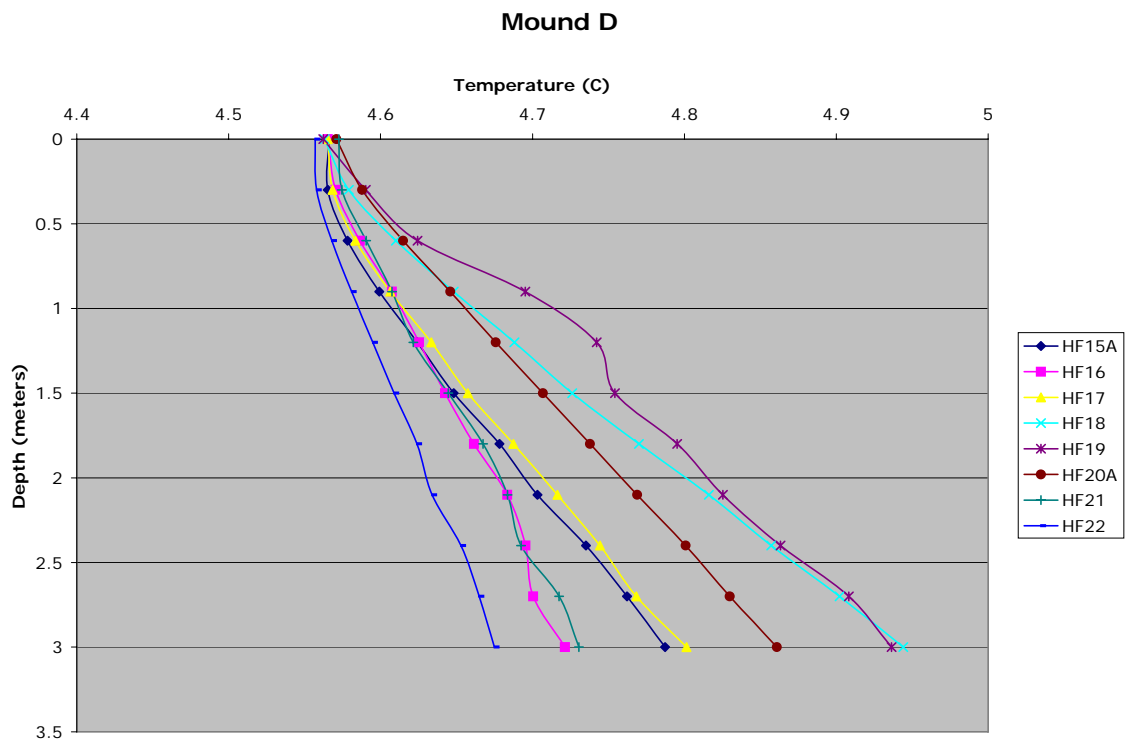


Figure 20. Temperature vs. depth plots for stations along transect over Mound D.

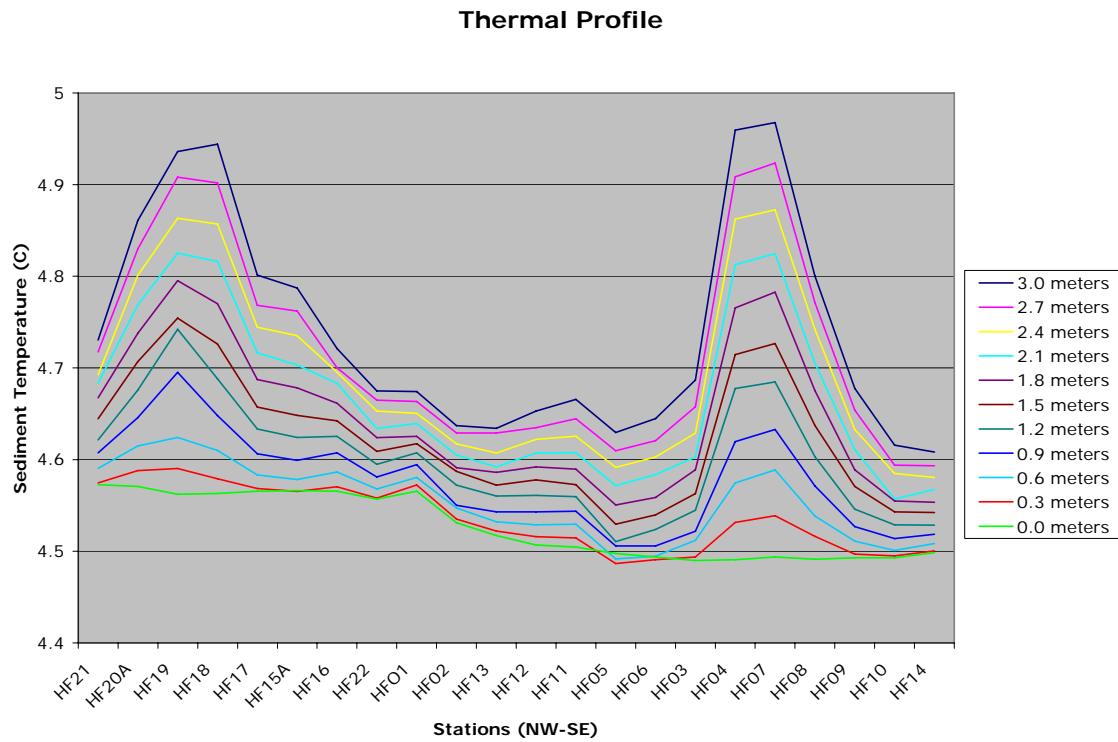


Figure 21. Thermal profiles for all thermistors along the entire transect.

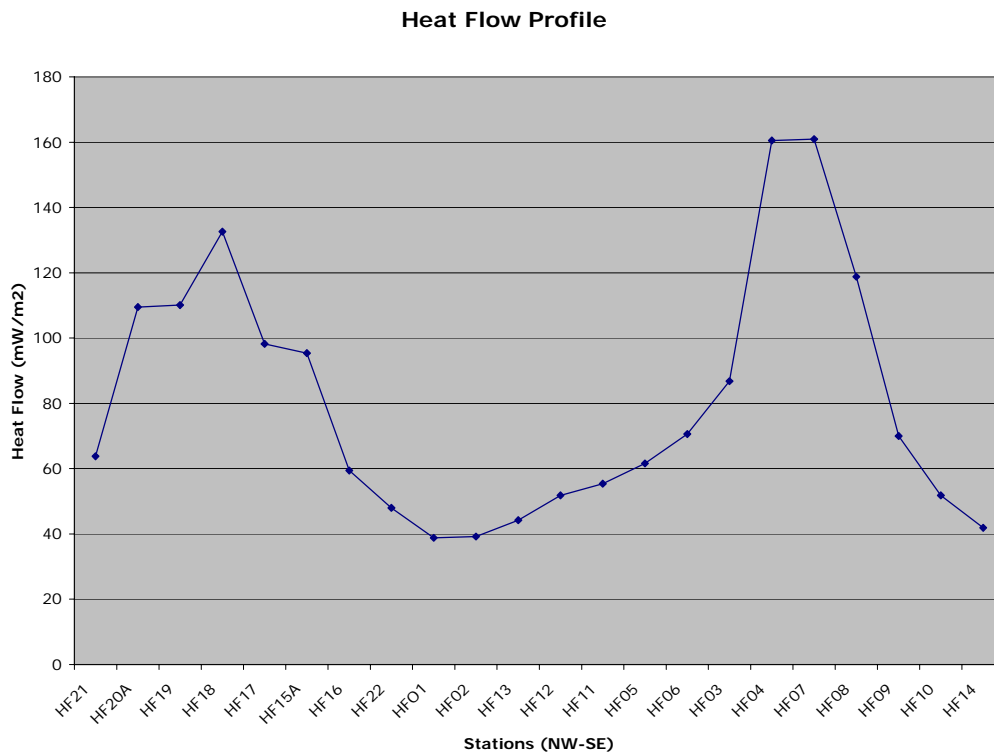


Figure 22. Heat flow profile for all stations along the transect from mound D to mound F.

V. SUMMARY

The following points are a general summary of the preliminary data review of the Atwater Valley research cruise. The data interpretation presented in this report will be revised with analyses that are being completed in the laboratory.

1. Geochemical analysis of sulfate and methane from piston core pore water samples shows a deeper SMI between mounds D and mound F. However, relative to other locations, the depth of the SMI between the mounds is shallow (Borowski et al., 1999).
2. Sulfate and methane pore water profiles from piston cores on mound F were found to have the largest vertical methane flux. Sulfate was depleted in surface core samples and methane concentrations were elevated, which suggests a flux of methane into the water column.
3. Research exploration of methane hydrates was conducted with a comparison of Keathley Canyon and Atwater Valley. The average SMI for Keathley Canyon was substantially deeper than Atwater Valley in the piston cores, with average values of 541 ± 155 mM (n=18) vs. 270 ± 132 mM (n=12), respectively. Also, data were not available from three of the cores on Atwater Valley because the high vertical methane flux inhibited sulfate data interpretation. Deep drilling conducted by during the Chevron-Texaco JIP will determine if the greater vertical methane flux measured at Atwater Valley results from greater pore water methane concentration from the hydrate bed because of more abundance of hydrates or greater hydrate dissociation and methane release resulting from the increases in pore water salinity caused by salt mounds in this region.
4. Stable carbon isotope and gas composition sampled from the piston cores has a predominately a microbial methane source. This is an interesting finding relative to identification of thermogenic methane in Atwater Valley at a depth of 1900 m to the south of mound F (Sassen et al., 2001). Future field surveys are needed for understanding local variation in the hydrate gas source(s).
5. Chloride data from piston cores did not indicate the presence of hydrates. However, high chloride concentrations were measured on mound F and may have masked the pore water freshening signal imparted during the dissociation of gas hydrate. It is expected that the chloride originates from deep salt mounds. This supports observation of vertical methane flow in this region.
6. DIC concentrations and stable carbon isotope analysis confirm anaerobic methane oxidation in the pore water profiles. Mound F sites show more shallow increases in DIC concentration and ^{13}C depleted DIC pools, indicating an increased vertical methane flow.
7. Data from the proposed Chevron-Texaco JIP deep well drilling sites was independently evaluated. Chevron-Texaco sites JIP-1 and JIP-5 are located on mound F. Methane, sulfate, chloride, DIC and DIC $\delta^{13}\text{C}$ all indicate this region is the most active in vertical methane flux. Sites JIP-2, JIP-3 and JIP-4 had deeper SMIs, but still indicate substantial

methane flux and are shallow relative to 10 m to 100 m SMI reported in other coastal regions (Borowski et al., 1999).

8. Through the region cored there is a large variation between the methane and chloride concentrations measured away from mound F, at the base of mound F and on top of mound F. With the high correlation between chloride and methane concentrations indicating a decrease in hydrate stability resulting from salt diapir mineral flow into the pore water these data will assist in selection of the deep drill locations and data interpretation.
9. The data show clear anomalies in sediment temperature and heat flow associated with the mounds. Measurements collected on the top of mound F show sediment temperatures elevated by 0.3°C relative to the surrounding seafloor, and heat flow values of around 160 mW/m^2 . Sediment temperatures decrease away from the summit of the mound, and heat flow values drop to a background level of 40 to 50 mW/m^2 . Sediment temperatures at the summit of Mound D are similar to what was observed at Mound F, and heat flow values are slightly lower at around 132 mW/m^2 , partly as a result of the slightly higher bottom water temperature and thus reduced thermal gradient.
10. Data from the Atwater Valley piston coring and heat flow show similar active regions for vertical methane flow.

VI. FUTURE GOALS

1. The geochemical and heatflow data is being compared with the NRL DTAGS seismic survey of this region that is planned for February 2005. These data will be used to plan future methane hydrate surveys in the Gulf of Mexico, on the Texas-Louisiana Shelf.
2. Radiocarbon isotope analysis of sediment organic carbon may provide a better understanding of the existing data.
3. The data base will be reviewed for planning future seismic, coring and heatflow surveys of this region.
4. Data will be provided to the Chevron-Texaco JIP for planning and interpretation of the deep drilling in this region.
5. Current and future data will be compiled for peer review manuscript(s).

VII. ACKNOWLEDGMENTS

This research cruise received strong support in the piston coring site selections from the seismic profiles provide by Drs. Deborah Hutchinson and Patrick Hart, US Geologic Survey. We appreciate the assistance in coring and heatflow data collection provided by the crew of the RV Gyre. This research was funded by DOE/NETL, ONR and NRL.

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APPENDIX 1: Pore water data summary from Atwater Valley piston coring.

| GOM_JIP_2 Cruise, May 2004 | | | | | | | | | | |
|----------------------------|---------|-------------------------------------|---------------|--------------|----------|----------------------------|-------------------------------------|--------------|----------------------|----------|
| Pore Water Data | | | | | | | | | | |
| Core | Syringe | Pore Water Depth Below Surface (cm) | Chloride (mM) | Sulfate (mM) | DIC (mM) | $\delta^{13}\text{C}$ -DIC | Gas Sample Depth Below Surface (cm) | Gas Sample # | CH ₄ (mM) | SMI (cm) |
| 1 | C011 | 5 | 562.5 | 28.1 | 3.6 | -15.4 | 0 | 11 | 3.79E-04 | 288 |
| 1 | C010 | 40 | | | 4.0 | -20.8 | 35 | 10 | 5.31E-04 | |
| 1 | C009 | 65 | 560.6 | 26.4 | 4.3 | -20.4 | 60 | 9 | 7.24E-04 | |
| 1 | C008 | 90 | 554.2 | 26.1 | 4.6 | -29.3 | 85 | 8 | 7.16E-04 | |
| 1 | C007 | 115 | 557.6 | 25.5 | 5.1 | -24.7 | 110 | 7 | 8.75E-04 | |
| 1 | C006 | 140 | 566.9 | 25.1 | 5.7 | -27.7 | 135 | 6 | 1.01E-03 | |
| 1 | C005 | 165 | 557.3 | 22.8 | 7.3 | -31.1 | 160 | 5 | 1.64E-03 | |
| 1 | C004 | 190 | 558.5 | 19.2 | 10.8 | -35.5 | 185 | 4 | 2.45E-03 | |
| 1 | C003 | 215 | 576.3 | 16.0 | 11.5 | -38.4 | 210 | 3 | 7.00E-03 | |
| 1 | C002 | 240 | 563.1 | 10.4 | 14.7 | -42.0 | 235 | 2 | 1.93E-01 | |
| 1 | C001 | 265 | 555.5 | 2.2 | 19.1 | -42.9 | 260 | 1 | 4.46E-01 | |
| 2 | C030 | 5 | 548.5 | 28.2 | 2.8 | -9.4 | 0 | 30 | 6.00E-04 | 410 |
| 2 | C029 | 35 | 551.1 | 27.6 | 3.3 | -14.6 | 30 | 29 | 9.34E-04 | |
| 2 | C028 | 70 | 562.9 | 26.7 | 4.2 | -19.9 | 65 | 28 | 8.13E-04 | |
| 2 | C027 | 105 | 550.6 | 25.1 | 5.0 | -23.3 | 100 | 27 | 8.73E-04 | |
| 2 | C026 | 140 | 551.0 | 24.6 | 5.2 | -25.8 | 135 | 26 | 1.01E-03 | |
| 2 | C025 | 165 | 557.9 | 23.8 | 5.9 | -28.6 | 160 | 25 | 1.10E-03 | |
| 2 | C024 | 190 | 555.7 | 21.8 | 7.3 | -31.9 | 185 | 24 | 1.00E-03 | |
| 2 | C023 | 215 | 550.1 | 20.5 | 8.2 | -32.7 | 210 | 23 | 1.31E-03 | |
| 2 | C022 | 240 | 549.9 | 19.5 | 8.4 | -33.8 | 235 | 22 | 1.45E-03 | |
| 2 | C021 | 265 | 528.3 | 17.0 | 9.5 | -36.2 | 260 | 21 | 1.38E-03 | |
| 2 | C020 | 290 | 553.9 | 14.1 | 12.0 | -40.4 | 285 | 20 | 2.86E-03 | |
| 2 | C019 | 310 | 549.0 | 9.1 | 15.6 | -43.7 | 305 | 19 | 1.13E-02 | |
| 2 | C018 | 330 | 554.8 | 2.8 | 19.5 | -47.1 | 325 | 18 | 3.46E-02 | |
| 2 | C017 | 350 | 535.1 | 0.5 | 20.0 | -41.5 | 345 | 17 | 1.39E+00 | |
| 2 | C016 | 375 | 547.7 | 0.9 | 16.9 | -30.8 | 370 | 16 | 8.42E+00 | |
| 2 | C015 | 400 | 551.5 | 0.4 | 14.3 | -22.4 | 395 | 15 | 8.91E+00 | |
| 2 | C014 | 420 | 552.5 | 0.0 | 13.0 | -17.7 | 415 | 14 | 1.20E+01 | |
| 2 | C013 | 440 | 546.7 | 0.0 | 11.9 | -13.4 | 435 | 13 | 1.25E+01 | |
| 2 | C012 | 465 | 557.5 | 0.1 | 10.3 | -10.3 | 460 | 12 | 9.96E+00 | |
| 3 | C044 | 5 | 680.1 | 1.2 | 13.6 | -42.9 | 0 | 44 | 6.87E-02 | no SMI |
| 3 | C043 | 25 | 799.1 | 2.0 | 15.6 | -16.6 | 20 | 43 | 6.96E+00 | |
| 3 | C042 | 50 | 875.5 | 0.5 | 9.4 | -1.8 | 45 | 42 | 3.52E+00 | |
| 3 | C041 | 75 | 922.1 | 0.0 | 9.7 | 2.1 | 70 | 41 | 7.87E+00 | |
| 3 | C040 | 100 | 931.0 | 0.0 | 9.1 | 3.0 | 95 | 40 | 3.74E+00 | |
| 3 | C039 | 125 | 941.0 | 0.7 | 9.2 | 3.4 | 120 | 39 | 3.36E+00 | |
| 3 | C038 | 155 | 951.8 | 0.4 | 10.5 | 2.7 | 150 | 38 | 3.61E+00 | |
| 3 | C037 | 200 | 946.3 | 0.0 | 8.0 | 0.7 | 195 | 37 | 3.80E+00 | |
| 3 | C036 | 225 | 954.4 | 0.2 | 8.9 | -2.0 | 220 | 36 | 4.28E+00 | |
| 3 | C035 | 250 | 948.3 | 0.2 | 9.2 | 3.3 | 245 | 35 | 4.98E+00 | |
| 3 | C034 | 285 | 937.5 | 0.0 | 8.2 | 1.7 | 280 | 34 | 3.69E+00 | |
| 3 | C033 | 310 | 950.3 | 0.0 | 8.3 | 0.8 | 305 | 33 | 4.14E+00 | |
| 3 | C032 | 340 | 963.9 | 0.0 | 8.9 | 3.7 | 335 | 32 | 4.37E+00 | |
| 3 | C031 | 365 | 951.7 | 0.2 | 6.7 | 0.1 | 360 | 31 | 4.28E+00 | |
| 4 | C059 | 6 | 607.7 | 9.8 | 10.9 | -51.1 | 0 | 59 | 1.39E-01 | no SMI |
| 4 | C058 | 56 | 790.7 | 3.1 | 9.5 | -17.5 | 46 | 58 | 4.69E+00 | |
| 4 | C057 | 86 | 813.4 | 4.9 | 8.5 | -7.8 | 66 | 57 | 1.32E+01 | |

| | | | | | | | | | | |
|---|------|-----|-------|------|------|-------|-----|-----|----------|--------|
| 4 | C056 | 283 | 959.2 | 0.4 | 7.7 | 10.8 | 278 | 56 | 7.94E+00 | |
| 4 | C055 | 333 | 950.8 | 0.2 | 7.6 | 6.2 | 328 | 55 | 9.95E+00 | |
| 4 | C054 | 388 | 921.8 | 0.5 | 7.3 | 4.4 | 383 | 54 | 4.68E+00 | |
| 4 | C053 | 438 | 943.2 | 1.2 | 7.3 | 4.6 | 433 | 53 | 6.40E+00 | |
| 4 | C052 | 483 | 937.8 | 1.0 | | 0.7 | 478 | 52 | 5.79E+00 | |
| 4 | C051 | 528 | 955.5 | 0.3 | 7.2 | 5.8 | 523 | 51 | 6.05E+00 | |
| 4 | C050 | 568 | 939.0 | 0.1 | 6.7 | 4.7 | 563 | 50 | 8.21E+00 | |
| 4 | C049 | 603 | 865.8 | 0.0 | 6.2 | 5.6 | 598 | 49 | 7.29E+00 | |
| 4 | C048 | 643 | 977.6 | 0.0 | 6.9 | 6.0 | 638 | 48 | 3.92E+00 | |
| 4 | C047 | 701 | 980.3 | 0.0 | 6.9 | 0.4 | 693 | 47 | 1.74E+00 | |
| 4 | C046 | 758 | 793.9 | 0.0 | 5.9 | 3.5 | 753 | 46 | 6.28E+00 | |
| 4 | C045 | 833 | 888.9 | 0.0 | 5.8 | 4.6 | 828 | 45 | 6.58E+00 | |
| 5 | C072 | 5 | 553.4 | 28.5 | 2.6 | -6.8 | 0 | 72 | 4.75E-04 | 224.0 |
| 5 | C071 | 31 | 557.0 | 22.4 | 5.5 | -33.3 | 26 | 71 | 5.27E-03 | |
| 5 | C070 | 61 | 565.8 | 20.0 | 7.1 | -38.7 | 56 | 70 | 1.01E-02 | |
| 5 | C069 | 91 | 562.6 | 17.2 | 9.2 | | 86 | 69 | 1.54E-02 | |
| 5 | C068 | 131 | 571.2 | 14.2 | 10.1 | -43.3 | 126 | 68 | 2.41E-02 | |
| 5 | C067 | 156 | 568.6 | 15.7 | 11.5 | -45.6 | 151 | 67 | 3.37E-02 | |
| 5 | C066 | 186 | 574.5 | 12.0 | 12.8 | -45.4 | 181 | 66 | 6.15E-02 | |
| 5 | C065 | 211 | 583.6 | 8.0 | 15.1 | -49.4 | 206 | 65 | 9.93E-02 | |
| 5 | C064 | 236 | 586.5 | 0.0 | 13.9 | -48.3 | 231 | 64 | 1.81E+00 | |
| 5 | C063 | 261 | 579.9 | 0.1 | 18.1 | -32.0 | 256 | 63 | 5.57E+00 | |
| 5 | C062 | 291 | 599.2 | 0.8 | 15.8 | -21.1 | 286 | 62 | 1.08E+01 | |
| 5 | C061 | 316 | 605.2 | 0.0 | 14.0 | -11.9 | 311 | 61 | 1.09E+01 | |
| 5 | C060 | 341 | 619.9 | 0.0 | 11.0 | -6.2 | 336 | 60 | 1.05E+01 | |
| 6 | C084 | 6 | 576.3 | 23.6 | 5.2 | 7.3 | 0 | 84 | 4.11E-02 | 45.0 |
| 6 | C083 | 32 | 645.9 | 1.8 | 14.2 | 7.9 | 27 | 83 | 4.09E+00 | |
| 6 | C082 | 52 | 675.2 | 1.0 | 13.0 | 7.3 | 47 | 82 | 7.90E+00 | |
| 6 | C081 | 77 | 708.2 | 0.9 | 12.6 | 5.9 | 72 | 81 | 5.51E+00 | |
| 6 | C080 | 177 | 759.5 | 1.4 | 12.6 | 3.6 | 172 | 80 | 5.85E+00 | |
| 6 | C079 | 202 | 787.6 | 0.8 | 11.3 | -0.7 | 197 | 79 | 5.56E+00 | |
| 6 | C078 | 247 | 813.8 | 0.7 | 12.6 | -6.1 | 242 | 78 | 4.70E+00 | |
| 6 | C077 | 292 | 859.1 | 0.2 | 10.6 | -12.2 | 287 | 77 | 3.61E+00 | |
| 6 | C076 | 337 | 876.4 | 0.3 | 11.1 | -25.0 | 332 | 76 | 4.13E+00 | |
| 6 | C075 | 387 | 887.7 | 0.0 | 10.3 | -36.1 | 382 | 75 | 3.70E+00 | |
| 6 | C074 | 437 | 902.5 | 0.1 | 10.1 | -45.2 | 432 | 74 | 2.77E+00 | |
| 6 | C073 | 507 | 877.5 | 0.0 | 8.6 | -31.8 | 502 | 73 | 2.84E+00 | |
| 7 | C100 | 5 | 956.5 | 0.0 | 5.8 | 3.2 | 0 | 100 | 8.34E+00 | no SMI |
| 7 | C099 | 34 | 928.9 | 0.0 | 12.1 | -48.1 | 29 | 99 | 4.71E+00 | |
| 7 | C098 | 104 | 837.2 | 0.5 | 9.7 | -25.4 | 99 | 98 | 3.29E+00 | |
| 7 | C097 | 144 | 897.6 | 0.7 | 8.3 | -15.0 | 139 | 97 | 5.61E+00 | |
| 7 | C096 | 184 | 964.3 | 0.0 | 7.3 | -0.7 | 179 | 96 | 5.85E+00 | |
| 7 | C095 | 224 | 982.6 | 0.3 | 7.1 | 3.0 | 219 | 95 | 4.82E+00 | |
| 7 | C094 | 322 | 959.1 | 0.5 | 7.3 | 3.1 | 317 | 94 | 7.75E+00 | |
| 7 | C093 | 372 | 975.2 | 0.0 | 7.4 | 2.5 | 367 | 93 | 6.06E+00 | |
| 7 | C092 | 422 | 983.4 | 0.0 | 7.1 | 4.5 | 417 | 92 | 4.89E+00 | |
| 7 | C091 | 472 | 953.0 | 0.0 | 7.0 | 3.8 | 467 | 91 | 1.06E+01 | |
| 7 | C090 | 522 | 982.8 | 0.0 | 6.5 | 3.4 | 517 | 90 | 7.77E+00 | |
| 7 | C089 | 572 | 924.1 | 0.0 | 6.0 | 4.6 | 567 | 89 | 5.13E+00 | |
| 7 | C088 | 682 | 876.9 | 0.0 | 6.2 | 3.1 | 677 | 88 | 5.69E+00 | |
| 7 | C087 | 732 | 973.0 | 0.0 | 6.8 | -1.5 | 727 | 87 | 5.29E+00 | |
| 7 | C086 | 782 | 922.6 | 0.0 | 6.1 | 3.0 | 777 | 86 | 6.79E+00 | |
| 7 | C085 | 842 | 870.1 | 0.0 | 5.6 | 2.5 | 837 | 85 | 6.57E+00 | |
| 8 | T014 | 5 | 576.8 | 21.9 | 5.5 | -38.3 | 0 | 114 | 2.71E-02 | 59.0 |
| 8 | T013 | 30 | 620.0 | 8.3 | 11.3 | -54.7 | 25 | 113 | 8.76E-02 | |

| | | | | | | | | | | |
|----|------|-------|-------|------|------|-------|-----|-----|----------|-------|
| 8 | T012 | 60 | 672.7 | 1.5 | 13.8 | -44.3 | 55 | 112 | 7.10E+00 | |
| 8 | T011 | 85 | 679.6 | 1.3 | 12.1 | -37.9 | 80 | 111 | 9.92E+00 | |
| 8 | T010 | 115 | 717.5 | 1.0 | 12.0 | -29.3 | 110 | 110 | 1.30E+01 | |
| 8 | T009 | 150 | 755.2 | 0.3 | 11.5 | -18.1 | 145 | 109 | 9.77E+00 | |
| 8 | T008 | 185 | 782.7 | 0.3 | 11.2 | -7.4 | 180 | 108 | 7.23E+00 | |
| 8 | T007 | 220 | 788.1 | 0.6 | 11.5 | -4.7 | 215 | 107 | 5.21E+00 | |
| 8 | T006 | 260 | 824.0 | 0.3 | 9.8 | 0.2 | 255 | 106 | 5.32E+00 | |
| 8 | T005 | 310 | 854.9 | 0.1 | 10.8 | 2.0 | 305 | 105 | 5.46E+00 | |
| 8 | T004 | 370 | 868.8 | 0.1 | | 3.8 | 365 | 104 | 4.96E+00 | |
| 8 | T003 | 420 | 871.3 | 0.0 | 10.1 | 5.8 | 415 | 103 | 3.95E+00 | |
| 8 | T002 | 470 | 896.6 | 0.1 | 9.7 | 6.7 | 465 | 102 | 2.85E+00 | |
| 8 | T001 | 510 | 837.1 | 0.0 | 8.6 | 6.1 | 505 | 101 | 4.11E+00 | |
| 9 | T027 | 5 | 549.4 | 27.6 | 3.2 | -11.7 | 0 | 128 | 3.38E-03 | 291 |
| 9 | T026 | 36 | 547.2 | 24.8 | 4.3 | -24.7 | 31 | 127 | 8.32E-03 | |
| 9 | T025 | 61 | 503.7 | 19.6 | 5.7 | -31.4 | 56 | 126 | 8.83E-03 | |
| 9 | T024 | 86 | 543.2 | 18.8 | 7.3 | -36.8 | 81 | 125 | 1.18E-02 | |
| 9 | T023 | 111 | 548.0 | 13.0 | 10.2 | -41.5 | 106 | 124 | 1.67E-02 | |
| 9 | T022 | 151 | 546.9 | 7.9 | 13.1 | -41.9 | 146 | 123 | 2.09E-02 | |
| 9 | T021 | 191 | 553.2 | 1.2 | 17.1 | -44.8 | 186 | 122 | 5.84E-01 | |
| 9 | T020 | 231 | 549.8 | 0.6 | 17.2 | -29.3 | 226 | 121 | 6.06E+00 | |
| 9 | T019 | 271 | 556.0 | 0.1 | 13.0 | -14.1 | 266 | 120 | 1.09E+01 | |
| 9 | T018 | 311 | 557.1 | 0.0 | 10.5 | -6.2 | 306 | 119 | 1.37E+01 | |
| 9 | T017 | 351 | 543.7 | 0.0 | 10.0 | -2.0 | 346 | 118 | 1.33E+01 | |
| 9 | T016 | 391 | 557.9 | 0.0 | 9.4 | 0.8 | 386 | 117 | 9.94E+00 | |
| 9 | T015 | 431 | 546.9 | 0.9 | 8.0 | -2.3 | 426 | 116 | 1.08E+01 | |
| 10 | T038 | 7 | 558.0 | 28.9 | 2.7 | -6.7 | 0 | 139 | 1.79E-04 | 385 |
| 10 | T037 | 40 | 556.4 | 28.6 | 3.0 | -10.8 | 32 | 138 | 2.21E-03 | |
| 10 | T036 | 85 | 545.2 | 27.7 | 31.8 | -10.5 | 77 | 137 | 8.71E-04 | |
| 10 | T035 | 135 | 560.8 | 28.2 | 3.6 | -17.9 | 127 | 136 | 1.55E-03 | |
| 10 | T034 | 185 | 565.3 | 17.5 | 4.2 | -19.3 | 177 | 135 | 1.88E-03 | |
| 10 | T033 | 235 | 572.1 | 26.6 | 5.2 | -25.3 | 227 | 134 | 7.94E-03 | |
| 10 | T032 | 280 | | | 8.9 | -38.5 | 272 | 133 | 1.42E-02 | |
| 10 | T031 | 310 | 549.9 | 10.1 | 14.2 | -46.3 | 302 | 132 | 2.73E-02 | |
| 10 | T030 | 335 | 556.6 | 1.1 | 18.9 | -47.6 | 327 | 131 | 9.40E-01 | |
| 10 | T029 | 365 | 537.1 | 0.3 | 13.8 | -16.6 | 357 | 130 | 8.47E+00 | |
| 10 | T028 | 405 | 535.2 | 0.0 | 11.7 | -1.6 | 397 | 129 | 1.01E+01 | |
| 11 | T051 | 8 | 562.1 | 24.3 | | -31.5 | 0 | 152 | 1.26E-02 | 246.0 |
| 11 | T050 | 34 | 565.9 | 15.9 | 19.8 | -44.1 | 26 | 151 | 1.19E-02 | |
| 11 | T049 | 49 | 610.7 | 8.2 | 11.3 | -46.1 | 41 | 150 | 2.31E-02 | |
| 11 | T048 | 79 | 597.5 | 6.8 | 15.7 | -52.4 | 71 | 149 | 4.94E-02 | |
| 11 | T047 | 109 | 611.4 | 1.8 | 18.5 | -44.9 | 101 | 148 | 3.89E-01 | |
| 11 | T046 | 143.5 | 623.3 | 0.8 | 18.1 | -42.7 | 136 | 147 | 5.25E+00 | |
| 11 | T045 | 178.5 | 640.5 | 1.6 | 16.4 | -37.6 | 171 | 146 | 9.78E+00 | |
| 11 | T044 | 223.5 | 637.0 | 0.7 | 15.0 | -24.5 | 216 | 145 | 1.23E+01 | |
| 11 | T043 | 268.5 | 663.5 | 0.0 | 14.8 | -16.3 | 261 | 144 | 1.32E+01 | |
| 11 | T042 | 313.5 | 685.1 | 0.3 | 14.0 | -10.6 | 306 | 143 | 1.19E+01 | |
| 11 | T041 | 364 | 682.2 | 0.6 | | -9.6 | 356 | 142 | 9.78E+00 | |
| 11 | T040 | 419 | 674.3 | 0.0 | 11.3 | | 411 | 141 | 1.05E+01 | |
| 11 | T039 | 471 | 702.9 | 0.2 | 10.2 | -2.4 | 466 | 140 | 1.05E+01 | |
| 12 | T061 | 5 | 553.2 | 26.6 | 38.5 | -12.2 | 0 | 162 | 9.50E-04 | 317.0 |
| 12 | T060 | 30 | 581.2 | 28.2 | 3.4 | -15.3 | 25 | 161 | 1.22E-03 | |
| 12 | T059 | 55 | 558.1 | 27.4 | 3.3 | -14.3 | 50 | 160 | 9.88E-04 | |
| 12 | T058 | 80 | 560.1 | 27.4 | 3.6 | -17.1 | 75 | 159 | 1.07E-03 | |
| 12 | T056 | 150 | 563.8 | 25.6 | 4.9 | -23.4 | 145 | 157 | 1.50E-03 | |
| 12 | T057 | 155.5 | | | 4.0 | -19.1 | 110 | 158 | 2.37E-03 | |

| | | | | | | | | | | |
|----|------|-----|-------|------|------|-------|-----|-----|----------|-------|
| 12 | T055 | 185 | 565.2 | 23.9 | 5.8 | -27.2 | 180 | 156 | 3.19E-03 | |
| 12 | T054 | 220 | 561.9 | 19.7 | 8.1 | -33.5 | 215 | 155 | 6.22E-03 | |
| 12 | T053 | 255 | 567.0 | 15.1 | 10.7 | -38.5 | 250 | 154 | 1.05E-02 | |
| 12 | T052 | 295 | 563.1 | 2.9 | 16.1 | -39.8 | 290 | 153 | 6.86E-01 | |
| 13 | T071 | 5 | 558.0 | 27.3 | 4.4 | -15.0 | 0 | 172 | 1.23E-03 | 260.0 |
| 13 | T070 | 47 | 541.8 | 24.0 | 7.4 | -25.4 | 42 | 171 | 6.15E-03 | |
| 13 | T069 | 82 | 562.4 | 19.3 | 9.4 | -39.2 | 77 | 170 | 1.00E-02 | |
| 13 | T068 | 122 | 575.7 | 15.7 | 13.1 | -43.7 | 117 | 169 | 1.44E-02 | |
| 13 | T067 | 162 | 578.2 | 10.3 | 13.1 | -47.0 | 157 | 168 | 2.13E-02 | |
| 13 | T066 | 202 | 585.0 | 5.1 | 13.4 | -43.9 | 197 | 167 | 3.96E-02 | |
| 13 | T065 | 242 | 588.8 | 0.9 | 19.7 | -46.2 | 237 | 166 | 6.94E-01 | |
| 13 | T064 | 277 | 631.3 | 0.0 | 18.4 | -40.5 | 272 | 165 | 5.95E+00 | |
| 13 | T063 | 307 | 593.1 | 0.6 | 15.9 | -27.5 | 302 | 164 | 1.27E+01 | |
| 13 | T062 | 342 | 616.9 | 0.6 | 11.5 | -11.2 | 337 | 163 | 1.56E+01 | |
| 14 | T084 | 5 | 551.7 | 8.6 | 14.4 | -42.6 | 0 | 185 | 4.20E-04 | 504.0 |
| 14 | T083 | 50 | 567.9 | 29.1 | 32.8 | -6.4 | 45 | 184 | 1.81E-03 | |
| 14 | T082 | 100 | 560.5 | 27.0 | 3.7 | -15.9 | 95 | 183 | 1.89E-03 | |
| 14 | T081 | 160 | 562.9 | 26.7 | 4.4 | -18.6 | 155 | 182 | 2.03E-03 | |
| 14 | T080 | 210 | 557.1 | 26.9 | 4.2 | -18.7 | 205 | 181 | 3.07E-03 | |
| 14 | T079 | 265 | 561.5 | 25.9 | 55.4 | -21.4 | 260 | 180 | 3.54E-03 | |
| 14 | T078 | 315 | 553.6 | 24.0 | 5.6 | -26.1 | 310 | 179 | 3.24E-03 | |
| 14 | T077 | 355 | 568.4 | 23.7 | | -28.0 | 350 | 178 | 4.61E-03 | |
| 14 | T076 | 395 | 561.3 | 22.8 | 7.3 | -28.6 | 390 | 176 | 3.71E-02 | |
| 14 | T075 | 430 | 551.3 | 22.2 | 7.3 | -30.9 | 425 | 175 | 4.47E-03 | |
| 14 | T074 | 458 | 560.5 | 27.4 | 9.7 | -35.7 | 453 | 177 | 1.06E-02 | |
| 14 | T073 | 480 | 554.8 | 1.4 | 18.6 | -43.6 | 475 | 174 | 3.69E-01 | |
| 14 | T072 | 520 | 551.2 | 0.6 | | -24.8 | 515 | 173 | 8.63E+00 | |
| 15 | T092 | 5 | 554.5 | 28.6 | 2.5 | -7.2 | 0 | 193 | 2.44E-04 | 215.0 |
| 15 | T091 | 75 | 559.6 | 26.1 | 4.0 | -17.3 | 70 | 192 | 2.82E-03 | |
| 15 | T090 | 115 | 555.4 | 24.9 | 4.4 | -18.5 | 110 | 191 | 3.81E-03 | |
| 15 | T089 | 155 | 562.6 | 22.6 | 5.5 | -23.9 | 150 | 190 | 4.74E-03 | |
| 15 | T088 | 195 | 558.7 | 16.0 | 30.1 | -28.4 | 190 | 189 | 2.79E-03 | |
| 15 | T087 | 235 | 556.3 | 0.0 | 10.1 | -32.2 | 230 | 188 | 1.32E-03 | |
| 15 | T086 | 285 | 564.6 | 0.4 | 14.2 | -34.3 | 280 | 187 | 1.72E-01 | |
| 15 | T085 | 325 | 563.7 | 0.6 | 10.0 | -22.0 | 320 | 186 | 2.85E+00 | |